12-15-1978

Non-Professional Scuba Training Fatalities in the United States (1970-1976)

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Introduction

From 1970 to 1976 ninety seven fatalities occurred during scuba diving training courses taught by nationally recognized scuba certification agencies. Data from these fatalities was gathered and analyzed at the University of Rhode Island's National Underwater Accident Data Center (NUADC) from September 1977 to June 1978.

NUADC has been in operation since 1969 gathering information on underwater fatalities involving United States citizens. Funding for the ongoing research has been provided by grants from various federal agencies including, National Oceanic and Atmospheric Administration (NOAA), United States Coast Guard Underwater Safety Project Office, and the Department of Health, Education and Welfare. Since 1970, NUADC has published annual reports entitled United States Underwater Fatality Statistics (year). Data for underwater fatalities is supplied from a variety of sources. Early in its history, NUADC relied primarily on subscriptions to news clipping services which sent items regarding underwater accidents to NUADC, which in turn analyzed the available information and conducted an investigation of the accident. In more recent years as NUADC has become well known to both the diving community and various federal agencies the primary source of data has shifted to what are referred to as "official sources." These sources involve both agencies that gather accident data such as the Consumer Product Safety Commission as well as investigative agencies such as law enforcement and coroner offices.

Each accident at NUADC is transcribed into a computer coded format and stored on magnetic memory discs in the University computer.

In addition, there is a paper file on each case which includes clippings and investigative reports.

In the course of the research for this paper, 888 fatalities were reviewed from 1970 to 1976. From these 888 cases each case that involved a formal training course for non-professional scuba divers was noted. A formal training course is any scuba course taught by an instructor who is currently certified by a recognized certifying organization. These courses offer ratings from basic scuba diver to scuba instructor, with various ratings in between. Course requirements vary depending on the certifying agency. Over 80% of the training fatalities were students enrolled in a basic course. Typical minimum requirements for a basic course consist of approximately 30 hours of instruction of which at least 9 hours must be open water training. These fatalities were then investigated and data, which is reflected in the statistical tables in this paper, was obtained and analyzed. The cases included several fatalities which involved students engaged in water work that did not include the use of scuba gear. For example, a student instructor died while performing an endurance swim in a pool. Thus, the statistics in this psper in some instances do not exactly correspond to the data published in the yearly underwater fatality reports, where training fatalities include only divers actually using scuba equipment.

After analysis of each case and compilation of data for the statistical tables, an effort was made to look for specific trends that occurred over the course of the period investigated. For example more fatalities seem to be occurring in which a boat is used as the diving platform and these dives tended to be to a greater depth than corresponding dives made from the shore. The small statistical sample,

however, dictates that caution should be exhibited when giving credence to any apparent trends.

In the course of analysis it became evident that a high percentage of training fatalities occurred to students who were diving in less than perfect environmental conditions. A strong relationship appears to exist between high stress levels in the victims and cold water.

Questionable decisions on the part of the instructors were evident in approximately 10% of the fatalities. These cases included ones in which serious mistakes were made by the instructor. The figure could be higher but sufficient data did not exist to substantiate this without totally subjective analysis.

An effort was made throughout the paper to examine the statistics as objectively as possible. Any deductions that were made have been remarked upon in the body of the paper.

It is the hope of the author that a close scrutiny of this report and the errors that have occurred in the past can aid in making diving instruction a safer and more profitable pastime.

Part I

Historical Background

The formal instruction of recreational or sport diving in the United States is a comparatively recent phenomenon, confined for the most part to the period following 1959. Recreational diving as a sport did not become popular until the 1950's when the introduction of scuba (an acronym for self contained underwater breathing apparatus) revolutionized the sport. Previous to the introduction of scuba equipment a sport diver had two options. One was skin diving using only mask, fins, and snorkel. The obvious drawback to skin diving was that a diver could stay submerged only as long as he could hold his breath - in most cases no longer than several minutes. The other option to a person seeking underwater enjoyment was to purchase an air compressor and dive using a surface supplied hose system. This setup was not inexpensive and in addition, the diver had little mobility as he could go no farther than the length of his air hose. A person who was interested in learning to scuba dive in the infant days of the sport could either strap on a recently acquired set of tanks and regulator and engage in an exercise of self instruction or rely upon a friend who had already made a number of dives himself and was thus considered proficient enough to impart the required knowledge. Not surprisingly, scuba instruction in the early days was based totally on practical experience.

In the beginning there was limited concern about the numerous safety considerations involved in scuba diving. This was due to a number of reasons, the first of which was that the diver learning to scuba dive at the time was more often than not already skilled in the art of skin diving

and had a strong aquatic background. To progress to the use of scuba was the logical next step if a diver wanted to advance his or her level of skill and enjoyment of the underwater environment (the vast majority of divers at this period were males). The prevalent feeling was that a novice scuba diver already had the prerequisite aquatic experience which made them aware of the inherent dangers of the sport. Another reason for the lack of standardized scuba instruction was the tendency for divers to affiliate themselves with a diving club. Affiliation with a diving club had various benefits such as; increased diving opportunities with experienced divers, instruction by divers who were considered proficient enough to teach novice divers and use of club equipment which lowered the initial cost of participating in the sport.

Inevitably scuba diving became an increasingly popular form of recreation and began to appeal to a larger segment of the population. As the sport acquired new popularity in the early 1960s, it soon became apparent that training was essential and some form of standardized training desirable. Standardized scuba instruction in the United States lagged considerably behind other countries (most notably, Great Britain and France where the sport actually began). In countries where sport diving had become popular by this time a single nationwide certification association had been set up. But this was not the case in the U.S. where the first attempts at formal certification began in the late 1950s.

Some early scuba certification courses consisted of approximately twelve hours of instruction. This instruction emphasized physical conditioning (usually acquired by swimming laps in a pool) and the memorization of various facts about the effects of changes in atmospheric pressure

on a diver's physiology. Instructor certification at this time was a somewhat flexible process in certain cases. One procedure was for an experienced diver to prove to a certifying agency that he was qualified and if the agency was convinced the diver was certified as an instructor.

In the early 1960s the instructional aspects of scuba diving began a marked change. As the sport entered a period of rapid expansion, efforts were made to convince prospective scuba divers that scuba lessons taught by one of several recognized certifying agencies were necessary for the prospective diver's safe enjoyment of the sport. Such a course resulted in the issuance of a certification of "C" card upon successful completion. The first certification cards were issued by Los Angeles County in 1955. The first instructional agency to certify divers was the Young Men's Christian Association (YMCA) in 1959. Other instructional agencies were soon formed to satisfy the growing demand of the sport. These agencies and the dates they were founded are: National Association of Scuba Diving Schools (NASDS) - 1960, National Association of Underwater Instructors (NAUI) - 1960, Professional Association of Diving Instructors (PADI) - 1968 and Scuba Schools International (SSI) - 1970. The typical curriculum which leads to certification as a basic scuba diver has changed considerably in the last fifteen years. The length of the basic certification courses has increased from 12 to 32 hours of instruction. In addition where the early scuba courses required no open water dives (conducted in a natural environment i.e. ocean, lake, or river) the current standards require a minimum of three open water dives and strongly encourage instructors to provide up to five open water experiences. Concurrently with the rise in the number of hours in the student courses precise standards and courses for instructors are now required by all the certifying agencies. In order to be certified, prospective

instructors must attend 200 hours of training, depending on the certifying agency, and meet certain prerequisites such as teaching a specified number of courses in the capacity of assistant instructor. Annual recertification of instructors is another added means of insuring quality control.

Scuba diving in the last 15 years has experienced a massive growth rate. From 1970-1974 alone the sport participation level increased over 200%.[1] A large part of the participation increase in the sport in this time frame has been due to technological advances in scuba diving equipment. In the early days of the sport relatively simple equipment provided sufficient capabilities for the diver. Divers were required to depend more upon their own physical abilities rather than relying upon the advanced technology of the equipment. The instructors at this time concentrated on developing and refining their student's swimming ability, physical conditioning and use of emergency procedures in case of equipment malfunction.

Such is not necessarily the case today. Students are now able to purchase, at no small expense, an impressive array of sport diving equipment. Virtually all of the new high technology equipment is aimed at making diving a safer sport for a wider market of consumers. Sophisticated buoyancy compensators, BCs in diving jargon, have greatly simplified a diver's ability to control his buoyancy. But simplicity is not necessarily inexpensive as they retail at prices up to $300. Another safety feature which is used by many divers, especially instructors, is the additional second stage regulator or octopus rig. Should a diver or his partner experience trouble with their primary regulator or lose their air supply two divers can simultaneously breathe from one air supply with the use of an octopus arrangement. The list goes on and on to include such "necessary" accessories as light emitting diodes (LED), meters which measure the nitrogen saturation

in a diver's body tissues.

As divers have become more equipment oriented, so have the philosophies involved in their training. The emphasis now is on the use of assorted mechanical devices to aid the diver in the event of an emergency rather than the application of the diver's basic skills.[2] As divers could increasingly depend on their equipment to substitute for basic requirements such as good physical conditioning and previous aquatic experience the sport broadened its appeal - attracting students for the most part who had had limited exposure to the open water environment.

Diving has always maintained somewhat of a challenging or daredevil mystique. Its initial appeal was to people who took pride in the fact that they were engaging in an activity which they perceived as beyond the capabilities of the common man. While diving has expanded its appeal to include all ages and segments of the society, the aura of hazard is still manifested in the appeal of several aspects of the sport, most noticeably in such sport diving activities as cave diving and the desire to make deep dives (dives to a depth greater than the accepted maximum of 130 feet). Cave diving on an annual basis from 1970 to 1976 has accounted for an average of 14% of the total recreational scuba fatalities in the U.S.[3] Some sport divers equate diving skill with the ability to make excessively deep dives. As diving equipment has become more sophisticated the appeal of the sport is no longer confined to people that are seeking to satisfy a psychological challenge. New diving equipment has made the sport less physically demanding and has removed the stigma that diving is essentially a risky sport.[4]

Thus, in the mid-nineteen sixties, recreational diving entered a transitional phase culminating in a broader range of participants, those who not only had more leisure time to devote to recreation but perceived diving

as a relatively low cost recreational activity, well within their physical capabilities. As a result, there came the need for increased instructional opportunities and the subsequent formation of the certifying agencies that now dominate the field.

The standards of instruction as stipulated by each of these agencies are similar for the most part, however, there are some important differences. An example is the depth at which training dives in open water are to be conducted. PADI has dictated that basic courses conduct open water dives at depths between 20 and 30 feet. NAUI though did not adopt rigid depth guidelines until late 1972. Their instructor's manual requires that instructors conduct all open water dives at depths between 20 and 40 feet.[5] With the exception of NASDS the major agencies require a minimum of three open water experiences (NASDS requires four) consisting of "at least 9 hours of training in around or about open water. At least one hour of the open water training to be underwater on scuba."[6] In addition to the open water instruction, each basic student receives approximately 24 hours of classroom and pool instruction. The final open water dive of the basic course is the final checkout dive and following successful completion of this dive the student receives a certification card. "C" cards are required in certain states (i.e. California) before a diver can obtain refills for his air tank or rent any scuba equipment. All the certifying agencies strongly encourage dive shops not to sell air or rent any equipment to divers who do not possess valid "C" cards.

The National Scuba Training Council (NSTC) was created in 1974. The purpose of the NSTC, which was comprised of representatives from YMCA, NAUI, PADI, and NASDS, was to create a body which would act as the representative group for scuba diving instruction in the United States. At the same meeting

at which the four major training agencies voted to create the NSTC the agencies agreed to comply with national standards which might be enacted in the field of diving instruction, the criteria of which would be overseen by NSTC. As the Director of PADI at the time stated, the move to create the NSTC was not entirely void of external motivation. "This move was preceded by a number of attempts by local governments to license and control diving on the state level, with the misguided approach that there were no existing standards or controls on diver training, and that this had led to an increase in diving accidents."[7] The issue of diving legislation centered around a Los Angeles County ordinance enacted in October of 1974 which imposed rather stringent requirements on the industry (i.e. scuba divers had to be recertified every other year).[8] The impetus for the ordinance (according to the certification agencies) was a series of articles in the Los Angeles Times purporting that "anyone can teach diving," and the "public is the victim of unscrupulous commercial interests." The articles further stated that 22 deaths had occurred in the County this year. Large three inch front page headlines proclaimed "SCUBA DEATHS" in a reporting fashion similar to the outbreak of World War II.[9] After the series of articles in the L.A. Times suffered certain credibility setbacks (some of the 22 reported deaths occurred in other counties and the victims in some cases were actually commercial divers - the actual number of L. A. County fatalities totaled 10 in 1974), the certifying agencies united in an attempt to prevent "what was once a simple sport from becoming a restrictive, bureaucratic process."[10]

Although faced with an increase in fatalities from scuba diving in the years immediately preceding 1974 the scuba certification agencies have maintained that while scuba fatalities have indeed increased, (109 fatalities in 1970 vs. 141 fatalities in 1974)[11] the rise in these recreational

scuba fatalities when juxtaposed against the 200% rise in diver participation in the sport over a corresponding period is relatively insignificant and in fact, the statistics show that scuba diving has become a safer sport. To further prove this contention that diving is a safer sport the agencies have pointed out that the approximately one million divers that became participants in the sport from 1950 to 1970 are still part of the population base exposed to possible diving accidents.[12] There is no doubt some validity to this argument, although when the training agencies are throwing statistics back and forth there is a great deal of room for overlooking certain realities in order to provide numbers which tend to support an already formed conclusion. An example of this would be that the figure of one million divers that became participants between 1950 and 1970 does not reflect the percentage of divers that learned to dive and subsequently lost interest in the sport and became what is known as "diving dropouts." Various articles have indicated that anywhere from 45-90% of all certified divers stop actively diving within one year of their final checkout dive.[13] The point being made here is that there is no accurate way to measure diver participation, although enough figures are offered to the contrary. What can be assumed (due to the fact that fatality statistics are a highly accurate figure) is that diving is indeed a safer sport when measuring diver fatalities vs. increased participation in the sport - whatever the actual percentage may be.

The statistical ambiguities of diving participation is particularly evident in the area of the number of divers who are certified annually. According to a Sea Grant Diving Safety Research Project, the number of students taught in 1975 that were certified was 253,104.[14] However, this figure may be misleading for several reasons. First the data does not

differentiate between divers receiving basic certification and those who are receiving advanced certification. Secondly, the study has no way of discerning the number of students that at the end of their course received certification from more than one agency. Multiple certifications occur when a scuba instructor is certified by more than one training agency and he or she in turn certifies their students with more than one agency. Multiple certifications are generally regarded within the training industry as somewhat of an anathema. They result to a large degree due to the competitive aspects involved between the various agencies. The expressed fear was that certain "cards were no longer acceptable everywhere by everyone."[15] The result was that instructors, in order to give maximum benefits to their students, issued several cards. There is no accurate manner to tally the number of divers who receive more than one "C" card. This problem is symptomatic of the inability of the training agencies to achieve complete cooperation, the NSTC not withstanding. In the interim, the agencies will continue to "waste time, money, and effort issuing multiple cards "[16] until each agency adopts a universal recognition policy.

An article in NAUI News entitled, "Some True Facts on Scuba Diving" states "from 1970 to 1973 a total of 685,928 divers were certified."[17] On an annual average for those four years, 171,482 were certified. Taking into account that diver participation has increased since 1973, a conservative estimate would be that between 175,000 - 200,000 divers are certified annually in the U.S. Granted, these parameters are rather large but given the lack of a central statistical source for diver certification and the previously discussed problem of multiple certification, any figure is subject to a certain amount of justifiable speculation.

The diver certification agencies adamantly maintain that sport diving is safe and is becoming safer. The agencies quote "statistics as kept by

the National Safety Council that provide documented proof that verifies this position..."[18] The agencies also freely quote their own statistics. Two examples:

> The number of divers certified per year has doubled in four years while the accident rate has increased only 5%, causing a decrease in the fatality rate. This is a remarkable safety record, but even more impressive is that the number of open water exposures per diver during training has also doubled during this period. In addition there is a 20% dropout rate during diving classes, so the number of persons exposed to some scuba training is 20% higher than the number certified.

The same article continues:

> From 1970 to 1973 a total of 685,928 divers were certified. Not even allowing for class dropouts and using an average of three open water exposures, this is 2,057,784 training dives. During this period 462 scuba divers died but on searching all possible reports and records only 46 of these deaths were during instruction. This is a fatality rate of 0.00002 per dive.[19]

These statistics, with the exception of the actual fatalities, (this paper shows 45 fatalities while in training for the corresponding period) are subject to some questioning. The main point overlooked is that of the 685,928 certified how many received certification from more than one agency. If this is the case (and most authorities agree that it does exist and so far has proven to be an immeasurable statistic) than the total number of training dives would be much lower due to double counting. How much lower is another unanswerable question. Thus the fatality rate would in reality be somewhat higher than the figure of 0.00002.

Statistical analysis of diving safety is a subjective field due to the dearth of unquestionably accurate data. What is agreed however, is that diving is a safer sport than it was ten years ago and the training agencies predict that diving will become an even safer sport as the major certification agencies develop new and comprehensive training standards for divers and

instructors.

The one unarguable statistic is that between 1970 and 1976 ninety-seven fatalities occurred while scuba divers were in an instructional status. A significant percentage of these fatalities were the result of gross errors of judgement on the part of the personnel conducting the course and as such, were needless fatalities. This paper will present both a statistical and comprehensive analysis of these deaths in an effort to illustrate why the sport diver training fatality could and should be lower.

Part II

General Training Fatality Statistics

A total of 97 students or instructors died between 1970 and 1976 while involved in a formal recreational scuba course. Table 2-1 gives a breakdown of these fatalities by sex, year and instructional activity.

Table 2-1

FATALITIES BY TRAINING ACTIVITY

YEAR	1970		1971		1972		1973		1974		1975		1976	
SEX	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Students	8	0	6	1	11	2	10	1	13	4	18	3	12	1
Instructors	1	1	0	0	0	0	1	0	0	0	1	0	0	0
Totals	9	1	6	1	11	2	11	1	13	[illegible]	[illegible]	2	12	1
Total Nonprofessional Scuba Fatalities	99	11	106	8	107	12	[illegible]	[illegible]	12[illegible]	10	122	[illegible]	13[illegible]	10

Between 1970 and 1976 there were a total of 888 non professional scuba fatalities.[20] [illegible] of these fatalities occurred while students were in a

formal training situation. Another 29 (3%) fatalities occurred while divers were being taught - usually by a friend - in an informal situation. These statistics are not included in this study.

Table 2-1 indicates that the highest number of training fatalities occurred during 1974 and 1975 when training deaths accounted for 12 and 17% respectively of the total recreational scuba fatalities. These two years also reflected an increase in the number of overall recreational scuba fatalities which coincided with an increase in the participatory level of the sport. Female fatalities comprised an average of 13% of the training fatalities over the seven year period analyzed. The largest number of female fatalities occurred in 1972, 1974 and 1975 when 15, 23 and 14 per cent respectively of the fatalities were female.

Instructor deaths comprised 4% of the total training fatalities. It is difficult to make any constructive analysis of the instructor fatalities due to the unexplained circumstances surrounding the deaths. For instance, one case involved a 24 year old female assistant instructor who was in the water just beyond the surf line instructing a group of students. The victim then encountered unknown difficulties and sank to the bottom in 20 feet of water. She was found shortly thereafter with her regulator out of her mouth. In a case such as this it is impossible from the available data to ascertain what actually caused this fatality. Another somewhat mysterious death occurred to a 48 year old male also acting as an assistant instructor. The victim was highly qualified, as he was a former U. S. Navy diver, who regularly dove every two weeks. The victim was in the process of conducting a demonstration for the students. He swam out 25 yards, dove down in 12 feet of water and then popped up and waved to the students. The students then observed the victim splash and go underneath the water "in a

peculiar manner." They swam out and recovered the victim. A medical examiner ruled drowning as the cause of death. What actually precipitated the strange behavior of this experienced diver was not determined.

One instructor fatality was an apparent case of "bad air" - the only instance of such a death in all the 97 fatalities. The victim was swimming with his group and signalled that he was surfacing. Upon reaching the surface the victim was seen swimming in erratic circles and soom stopped breathing. A crime laboratory report noted 25.8% carboxyhemoglobin or carbon monoxide saturation based on total hemoglobin concentration. Unconsciousness occurs at approximately 30% carboxyhemoglobin with death at 70%. Although the relation between CO and depth is still disputed, some scientists maintain that CO of a given concentration becomes more toxic as depth increases.[21]

Training fatalities showed a marked decline in 1976 which is especially encouraging in light of the continued increase in diver certifications. Whether or not this augers well for the instructional community remains to be seen. The decrease in the training fatalities may be only a fluctuation due to the small size of the statistical sample and it is too early to predict any trends. However, if the number of instructional fatalities as a percentage of total recreational scuba fatalities continues to show a decline or remain constant while scuba certifications continue to increase it would indicate that the training agencies are succeeding in their attempt to make diving instruction a safer experience.

Table 2-2 is a breakdown of training fatalities by year and month.

Table 2-2

Fatality Distribution by Month and Year

Per Cent

	1970	1971	1972	1973	1974	1975	1976	*
January	0	0	0	0	6	0	8	5
February	10	0	0	8	0	9	0	4
March	10	0	23	0	12	18	23	8
April	0	0	7	17	12	18	14	9
May	0	60	8	8	17	4	23	12
June	20	0	8	25	12	9	8	9
July	0	0	8	8	5	4	8	14
August	20	10	8	8	12	14	8	12
September	0	0	0	18	0	14	8	9
October	20	20	7	0	6	10	0	6
November	10	0	0	8	12	0	0	6
December	10	10	31	0	6	0	0	6
Totals	100	100	100	100	100	100	100	100

* Average monthly distribution on an annual basis 1970-1976 for total non-professional scuba fatalities.

By calendar quarters the first quarter of the year is responsible for 18% of the fatalities, the second quarter 39%, the third quarter 22% and the fourth quarter 21%. With the exception of the second quarter, the fatalities are distributed on a relatively equal basis.

It is interesting to examine the fatalities which occurred from March to June. These four months accounted for 51 fatalities (53%). Of these 51 fatalities, 73% of them occurred in water which was considered cold -

a temperature below 55 degrees fahrenheit.

One case which illustrates the added physiological and psychological stresses placed upon the novice diver in cold water involved an 18 year old college student from a northern midwestern state. The lakes in the student's home state were still frozen in early March so in order to receive open water experience prior to certification it was necessary for the class to travel south to Missouri. The water temperature in the lake where the class dove was 48 degrees. The victim and his partner made a dive to 50 feet where the victim experienced difficulties with his air supply. The victim's buddy offered the victim his regulator in an attempt to initiate buddy breathing. Buddy breathing is the sharing of a diver's air supply with his buddy by alternating breathing from one regulator. At this point the victim panniced and pushed the buddy away. The buddy then surfaced to seek help. A subsequent search for the victim failed to locate the body. This case illustrates a series of events which frequently occur in cold water fatalities. The novice diver is cold and his already abnormally high respiration rate is increased even more by the temperature of the water.[22] A dangerously high stress level is reached due to both the physiological and psychological strains placed upon the diver by the combination of inexperience and cold water. The novice diver is then confronted with an abnormal situation such as an equipment failure, perceived or actual, and instead of being able to assimilate the emergency procedures he has been taught in the pool and the classroom and extricate himself safely from the situation, the diver panics which often leads to his death.

Another cold water fatality which points out how the novice diver's judgement is affected by the abnormal stress level occurred when the water temperature was 36 degrees and it was snowing. The victim was a 29 year old male

on his second open water dive. The victim was wearing a 1/4 inch neoprene wetsuit while the rest of the class was using the more appropriate 3/8 inch thickness. The victim was somewhat overweighted as he was wearing 34 pounds of weight on his weight belt. The victim and his buddy were proceeding underwater at a depth of 35 feet when they became separated. The victim, following accepted diving procedure, surfaced in order to locate his partner. Unable to see his buddy, the victim swam over to a pier piling and was soon conversing with several other students who had also surfaced. The victim appeared to be in satisfactory condition and the other students left in order to complete their dive. Upon completion of the class dive, it was discovered that the victim was missing. His body was recovered one hour later, fifteen feet from the piling. The victim's tank was empty and his flotation device had not been activated. It appeared that the victim had made an attempt to release his weight belt as only one inch of webbing remained beyond the weight belt buckle.

What happened to the victim in this case and how did the cold water aggravate the situation? The most plausible explanation is that the victim ran out of air on the surface after exhausting his reserve air supply. Then the victim began to sink due to his overweighted condition. At this point the victim apparently tried to release his weight belt but failed in the attempt. Had the victim been able to calmly assess the situation he would most likely have inflated his flotation device and waited for help. But the victim was fatigued and under a high level of stress which when combined and aggravated by the severe environmental conditions made it difficult for this diver to react in a manner which would have saved his life.

When compared to the total recreational fatalities for the corresponding years, the training fatalities are significantly higher, 53% vs. 38%, for

decided to go ahead and checkout their new regulators. The male victim was heard stating that he was going to stay down until he ran out of air in order to get a real test of his regulator. The victims proceeded to dive to 70 feet and failed to surface. The instructor commenced a search as soon as he learned that the divers had entered the water without his permission. The bodies could not be located that day as the search was hampered by low visibility. When the victims were located two days later the female was found with her mask off which could indicate that she may have had her mask kicked off by her partner in the murky water which resulted in a panic situation that ultimately claimed the lives of both divers.

There are two hazardous environmental factors which are common to all of the multiple fatality cases. The first is that all the dives took place in cold water. The additional stress this places on inexperienced divers has already been discussed. The second factor common to these cases is that all the dives were to a depth in excess of the depth limit established for basic scuba courses.

There is no reason for an instructor to place his or her students in a training environment that exposes the student to unnecessary hazards. It is extremely difficult for novice divers to react successfully to emergency situations when they are under excessive stresses. This is borne out by the cases where both of the buddy breathing attempts resulted in multiple fatalities. Emergency ascents from excessive depths are even riskier.

The distribution of training fatalities by state is given in Table 2-4.

Table 2-4

Training Fatalities by State and Foreign Area

Location	1970	1971	1972	1973	1974	1975	1976
Alabama	1	0	0	0	0	0	0
Alaska	0	0	0	2	0	1	0
Arkansas	0	0	0	1	0	0	0
California	5	0	3	3	3	4	3
Colorado	0	0	1	0	1	1	0
Florida	0	0	0	1	1	2	1
Georgia	0	0	0	0	1	0	0
Hawaii	0	1	0	0	0	2	0
Idaho	0	0	0	0	0	0	1
Illinois	1	0	0	0	1	0	0
Indiana	0	0	1	0	0	0	0
Iowa	0	0	0	0	0	1	0
Louisiana	1	0	0	0	0	1	0
Maine	0	0	0	0	1	0	0
Maryland	1	0	0	0	0	0	0
Mass.	1	1	1	1	0	0	1
Michigan	0	0	0	0	0	1	0
Missouri	0	0	1	0	1	0	0
Nevada	0	0	0	0	1	0	0
New Jersey	0	0	0	1	0	0	1
New York	0	2	0	0	0	0	0
Oregon	0	0	0	0	1	2	0
Rhode Island	0	0	1	0	0	0	0
South Carolina	0	0	0	0	0	0	1
Texas	0	1	2	0	0	2	0
Utah	0	2	0	0	1	0	0
Virginia	0	1	0	0	3	1	1
Washington	0	2	2	2	2	1	2
Wisconsin	0	0	0	0	0	1	0
Foreign Area							
Bahamas	0	0	0	0	0	1	1
Bermuda	0	0	1	0	0	0	0
Mexico	0	0	0	0	0	1	0
Okinawa	0	0	0	1	0	0	1
Totals	10	10	13	12	17	22	13

The leading state for training fatalities is California with 22% of the total. This is not surprising as California has a long coastline and is a prime market for the recreational industry. California's percentage of training fatalities is almost identical, 22% vs. 21%, to the percentage of

total recreational fatalities which occurred in the state. The second leading state is Washington which had 11% of the training fatalities. This is a somewhat larger percentage than the 7% total of recreational fatalities for the corresponding period. The one state that shows a marked decrease in training fatalities versus total recreational fatalities is Florida. Florida had only 4% of the training fatalities while the state had 24% of the total recreational deaths for the same period, more than any other state. This anomaly is possibly explainable for several reasons. First a high percentage of Florida's total recreational fatalities, 40%, are the result of cave diving.[24] Although cave diving is especially fatal to novice divers these divers are participating in cave diving outside any formal training situation. Secondly a significant percentage of Florida's remaining deaths occur to divers who are certified and are diving in Florida on vacation.

Although not included in the training fatality statistics, one case which involved a 17 year old male who had received his certification minutes prior to his death, illustrates the appeals and dangers of cave diving in addition to displaying poor decisions on the part of the student's instructor. The victim was in a class with over 40 other students who had traveled all night to a spring fed fresh water pool with several caves leading from it. The instructor had never been to the dive site and had to rendezvous with another group to find the pool. The students completed their final check-outs and were given their "C" cards and the instructor cautioned the newly certified divers not to go into the caves. After warning his students the instructor left the area to refill expended air tanks. The victim dove with two other novice divers and the group followed a more experienced set of divers into a cave. The group, which now consisted of five divers, swam into

the cave in order to view a small statue that had been placed in a small chamber. The cave was frequently used and had a safety line strung on the roof to aid disoriented divers. After the group circled the statue the victim apparently became disoriented in the low visibility and began swimming in an opposite direction from the group. Upon surfacing, the members of the group asked if anyone had seen the victim and they received a negative reply. The instructor when notified ordered a search of the cave and the victim's body was soon located. Inspection of the victim's tank revealed that the boy had 600 pounds of air remaining or approximately 7 minutes of air left at the depth at which he was diving. What most likely happened was that the victim realized that he was disoriented - inexperience prevented use of the safety line - and paniced at which point he most likely spit out his regulator even though he had sufficient air to reach the surface. Not only does this case show the sometimes fatal attraction cave diving has for novice divers but it also points some regrettable decisions on the part of the instructor. Furthermore, this case points out the necessity for diving instructors to insure that they maintain positive control of their classes at all times.

An interesting statistic can be obtained by determining what percentage of a state's total recreational scuba deaths occurred in a training situation. In this category Virginia has the highest percentage as 86% of the state's recreational fatalities were to student divers in a formal training status. The other states with high percentages in this category are: Colorado - 75%, Idaho and Nevada - 50% and Utah - 43%. The obvious correlation that is apparent when analyzing these cases is that with the exception of the Alaskan deaths all the fatalities occurred in fresh water and that with the exception of three of all the fatalities for these states

they all were cold water dives. These states, with the exception of Virginia, are not particularly active scuba diving regions. The result is that in these type regions it appears that a higher percentage of recreational fatalities will be to inexperienced divers who are in an aggravated stress situation.

Of the training fatalities involving U.S. citizens in foreign countries, half of the fatalities were to off duty U.S. military personnel.

Part III

Victim Profiles

Data collected from the case files of the training fatalities has permitted the analysis of various personal characteristics of the divers involved in training fatalities. Table 3-1 shows the age distribution of the victims.

Table 3-1

Age Distribution of Training Victims

Years	1970	1971	1972	1973	1974	1975	1976	*
0 -10	0	0	0	0	0	0	0	1
10-15	1	2(1)	0	2	1	0	0	21(3)
16-20	2	3	2	1	2	6(1)	2(1)	187(15)
21-25	(1)	3	2(1)	5	5(3)	3(1)	3	236(22)
26-30	0	0	2(1)	2(1)	2	4	3	144(12)
31-35	2	0	1	0	2(1)	2(1)	0	80(7)
36-40	0	0	2	0	1	2	0	49(2)
41-45	2	2	1	1	3	4	1	65(4)
46-50	0	0	1	1	0	0	1	39(4)
51-55	1	0	2	0	0	1	1	27(1)
56-60	0	0	0	0	1	0	0	18(1)
60+	0	0	0	0	0	0	1	8
Age Unknown	1	0	0	0	0	0	0	13
Totals	10	10	13	12	17	22	13	888

Note: Figures in parentheses indicate number of female divers in group.

* Age Distribution for Total Non-professional Scuba Fatalities 1970-1976.

The highest percentage of fatalities occurred in the 21-25 age bracket. This group accounted for 23% of the training fatalities. The next highest group is the 16-20 age bracket which comprised 18% of the total. This age distribution is to be expected. Scuba diving in particular, and outdoor recreation in general, has a large appeal to the 16-25 year old age level. That scuba diving is a physically active endeavor also means that it is

more likely to be attractive to this age group. In addition, opportunities for scuba instruction are more readily available for this age group. In order to meet the demand for an increased interest in outdoor recreation, an increase in the number and scope of experiential education courses taught by institutions of higher learning has come about. In the normal college age level, 18-23, 41% of the 27 fatalities recorded were participating in a college or university affiliated scuba course. These courses, both advanced and basic, are taught by instructors who may or may not be faculty members of the school in question. The students usually receive academic credit for the course as well as a certification card from the training agency with which the particular instructor is affiliated. 45% of the fatalities associated with an institution of higher learning occurred in the waters of Puget Sound, Washington. This area is associated with cold water diving but the abundant marine life makes it especially attractive for scuba divers. One fatality that occurred to a college student in this region is typical in that it shows that these courses are usually well conducted with safety conscious supervisory personnel.

The victim was a 22 year old male participating in an underwater lifesaving exercise as part of an advanced scuba course. The drill required the student to make a free dive without scuba gear in order to recover a simulated scuba victim lying on the bottom in 20 feet of water. A safety diver and an assistant instructor, both wearing scuba gear, were assigned to monitor the exercise. The victim dove to the bottom and made contact with the simulated victim. The safety diver observed the contact and surfaced to wait for the victim and simulated victim to surface. The simulated victim surfaced and reported he last saw the victim as he was heading for the surface. "Within 15 seconds" a search was started and the victim's body was

recovered 20 feet away from the exercise area within two minutes. The victim was placed in a safetyboat which "as a rule was always stationed within a 30 yard radius of any open water exercise." Despite extensive lifesaving efforts including both cardiopulmonary and mouth to mouth resuscitation the victim failed to respond. Witnesses estimated that the victim could not have been underwater in excess of 2½ minutes. Permanent brain damage does not usually occur unless a victim has been without oxygen in excess of 5 minutes. Thus, the victim was recovered well within the time limit to respond to successful resuscitative efforts. The actions of the training staff were timely and well coordinated and in most instances would have prevented a fatality.

Of the 6 cases involving students in the 10-15 year age group, 4 of these cases showed questionable judgement on the part of the instructors involved. The other two cases were the result of panic on the part of the students. One instance of panic resulted in the death of a 13 year old girl. The victim was on her first open water dive and was with a group of three other students who were being supervised by two instructors. While diving the girl lost a fin and paniced, grabbing her partner's mouthpiece out of his mouth. This resulted in the partner panicing and racing to the surface from 20 feet. The instructor asked the partner where the girl was and he replied, "right behind me." The instructor immediately initiated a search and located the girl's body on the bottom.

The following three cases involved possible questionable judgement by instructors. The first case involved a 15 year old boy who was making his first open water dive. The victim was diving with one other student and an instructor. After they had been diving one hour they all surfaced and proceeded to the beach. The victim still had some air remaining and he asked

the instructor if he could go back in the water and dive close to the shore until his air ran out. The instructor concurred and along with the other student, monitored the victim's air bubbles from the shore. Soon the victim's air bubbles stopped and the instructor began searching for the boy. The instructor searched for several hours in vain and then decided to contact the local authorities. The local police divers located the boy's body in 30 feet of water. The victim had run out of air but examination of the tank revealed that the boy had failed to activate his reserve air supply. This case is a classic example of violation of a primary tenet of scuba diving - never dive alone. Not only did the instructor condone the boy diving alone but the boy was highly inexperienced as indicated by his tragic failure to activate his reserve air supply. Unfortunately, this is not the only case in which an instructor was standing on the beach while a student who was diving alone experienced a fatal accident.

Another case is representative of a training situation in which the instructor conducts a drill which is beyond the ability of the student to complete in a relatively safe manner. Again the victim was a 15 year old male. In this instance, the victim was on his fourth open water dive and was to perform an exercise which consisted of a one mile run followed by a one mile swim and then the student was to make a "bail-out" dive. A "bail-out" dive requires the diver to jump off a boat with his tank and mask in one arm. The diver then descends along with two safety divers to the bottom, which in this case was 35 feet, and puts his tank and mask on and then ascends to the surface. As the boy was descending he motioned to the safety diver that he was not getting any air. The safety diver responded by giving the boy his mouthpiece and, according to the safety diver, the boy took two breaths but it appeared that he was holding his breath.

At this point the boy paniced and started fighting and kicked the safety diver in the face causing the safety diver to lose his mask and mouthpiece requiring an emergency ascent on his part. The safety diver surfaced bleeding from his nose and ears and yelled at the other divers on the surface who started a search right away. However, it took several hours for them to locate the boy's body which was found lying face down in the mud, the boy still clutching his tank and mask. The victim's gear performed well during a subsequent inspection. This type of an exercise invites a host of possible dangerous complications. In this case excessive psychological stress resulted in the victim making the erroneous assumption that something was wrong with his air supply. Another possible problem could arise if the participant was unable to equalize during the descent resulting in a probable ear squeeze leading to the diver reaching the bottom and being both disoriented and in intense pain. For an instructor to place a relatively inexperienced diver in this situation is an invitation to trouble. Again, this is not an isolated incident. Several other fatalities have occurred during performance of drills not required by the certifying agency but which instructor's perceive as an effective means of challenging their students.

The third case resulted in the death of another 15 year old boy. The dive took place in a man made lake in the southwest. The lake was known to have a very sharp drop off as well as numerous submerged trees which were difficult to see due to the generally low visibility of the lake's waters. The boy and two other divers requested permission from their instructor to make a deep dive to 100 feet. The instructor gave them permission and the three descended maintaining visual contact with the use of hand held lights. They got down to 105 feet and began their ascent. Upon reaching

80 feet the divers encountered a large tree and visual contact was lost with the victim while the divers were working their way up through the tree. The two divers surfaced thinking that the boy would be able to work his way up independently. This was a fallacy, however, as the boy never surfaced and despite an impressive attempt in the next two weeks to locate the boy his body was never found. Two important factors contributed to this fatality: one was the choice of a hazardous dive site that was not at all appropriate for novice divers; the second was the excessive depth of the dive.

In the middle-age group the need to pick up new leisure time activities leads to diving as a likely choice. Of the training fatalities, 26% occurred to victims over 40 years of age. Not surprisingly, all were male. The typical fatality in this group occurred in California (40%) and was the result of a physical limitation. The most common shortcomings were poor conditioning resulting in asphyxiation by drowning and heart or circulatory problems (i.e. arteriosclerotic heart disease) which resulted in a coronary insufficiency or heart attack.

One representative over 40 fatality occurred in Northern California. The 45 year old victim had completed a basic scuba course four months previously, but still had not performed his final checkout dive. The victim was an excellent student in the written portion of the course and according to his instructor, handled himself well in the ocean despite some problems which had forced candellation of two open water dives. The victim was learning to dive along with his wife. On the day of the fatal dive the wife was also scheduled to dive. She had expressed considerable concern about her lack of conditioning. She was towed in from her last dive because of physical exhaustion. Her husband's poor physical shape also concerned her. At the last minute she declined to participate in the dive worried that she

would spoil the dive for her husband. There was a moderate 3 foot surf running and the victim proceeded to enter the water with an assistant instructor and three other divers. All the students experienced some problems with the surf but it was a particularly arduous exercise for the victim as he had a reluctance to duck under the waves. This resulted in his being continually knocked down in the surf zone. After a moderate amount of exertion and a high amount of anxiety, all the students got outside the surf zone and were ready to commence their dive when the victim approached the instructor and said he was tired and would prefer going back into the beach. The instructor got the attention of a group on the beach, including the victim's wife, by waving as he accompanied the victim ashore. When the attention of the group was caught, the instructor, assuming the group would ensure the safe arrival of his student, proceeded to return to his group of students. The victim was only several yards offshore but, in the surf zone and being knocked over repeatedly. The victim's wife entered the water and struggled to help her husband out of the surf. However, she was not strong enough to support the weight of her husband. The wife saw that her husband, who by this time had ingested a good deal of water, was cyanotic with foam coming out of his mouth. She, therefore, tried mouth to mouth resuscitation but the waves made this ineffective. At this juncture other members of the group arrived and the victim was placed above the waterline and an M.D., another student, commenced efforts at resuscitating the victim. Again, this effort was ineffectual and the victim arrived dead at the hospital.

Though the victim was escorted to a point where he could stand up and other students were moving down to help the victim the remaining few feet, the student's poor physical conditioning and high anxiety level should have been taken into account.

Table 3-2 lists the primary occupations of the training victims.

Table 3-2

Victim's Occupational Status

YEARS	1970	1971	1972	1973	1974	1975	1976
Student	2	4(1)	3	5	2(1)	5(1)	3
Military (Off-Duty)	1	0	1	2	1	2	2
Educational Field	2	0	0	1	0	0	0
Medical Field	0	1	4(2)	0	2(1)	2	1
Engineer	1	0	1	1	0	1	0
Clerical	1	0	0	0	0	1	1
Misc. (Professional)	0	1	3	0	3	2	0
Misc. (Non-Professional)	0	0	0	0	2	2	0
Unknown	3(1)	4	1	3(1)	7(2)	7(2)	6(1)
TOTALS	10	10	13	12	17	22	13

Note: Parentheses indicate number of females in group.

Scuba diving has a high appeal to people in the 16-25 age group which accounts for the fact that 25% of the victim's occupations that could be ascertained were students. The next highest groups were service personnel and people employed in the medical profession. These groups each accounted for 9% of the victims with identifiable vocations. From the occupational distribution it can be seen that diving appears to be a sport primarily participated in by whites of the middle and upper middle class. Less than 3% of the victims were non-white and all of these victims were black.

The appeal diving has to the white collar professions can be most clearly demonstrated when examining the professions of the training victims over 40 years of age. Occupational data was available for 15 cases in this

category. Of the 15 victims, thirteen were in professional occupations normally associated with an above average income. The two victims that could be classified as average wage earners were a policeman and a tool and die maker. The most common age group in this category was that of physician.

Part IV

Environmental Aspects of Training Fatalities

The location where the training fatalities occurred is listed in Table 4-1.

Table 4-1

Location of Training Fatalities

Year	1970	1971	1972	1973	1974	1975	1976	*
Ocean, Bay, Sea	7	5	8	9	7	12	10	542
Lake	1	4	4	1	7	6	2	161
Quarry	0	1	0	0	2	2	1	28
River	0	0	0	1	0	1	0	32
Swimming Pool	2	0	1	1	1	1	0	4
Cave	0	0	0	0	0	0	0	121
Totals	10	10	13	12	17	22	13	888

* Location for total nonprofessional scuba fatalities 1970-1976.

Sixty percent of the training fatalities occurred in salt water. This is nearly equal to the total recreational fatalities where 61% of the total occurred in salt water. The percentage of training fatalities that occurred in lakes is somewhat higher, 26% vs. 16%, than the total recreational fatalities.[25]

When comparing training fatalities that occurred in fresh water to the total number of recreational fatalities it becomes apparent that fresh water

diving may be more hazardous to the novice diver than corresponding salt water dives. 34% of the training fatalities took place in fresh water as compared to 25% of the total recreational deaths. The latter figure does not include cave diving because in the author's opinion cave diving presents an entirely unique set of circumstances. Of the training fatalities that occurred in fresh water, over 2/3 of the cases involved dives made in cold water. This reinforces the previously discussed adverse effects cold water has upon a novice diver.

Two fresh water locations in particular have proven to be exceptionally hazardous to student divers. They are manmade lakes in the midwestern and Rocky Mountain states, and quarries, most notably in Virginia.

One fatality points out the shortcomings of utilizing such locales for scuba training. The victim was a 24 year old female who had travelled to the lake from her home in another mid-western state. Her diving group had driven all night to arrive at this particular dive site the next morning. The victim had complained to a friend that she was suffering from diarrehea as well as a headache but, upon arrival at the location she took some pain killers and prepared for her first open water experience. The water temperature was 48 degrees with very low visibility as well. The dive was conducted without incident and the group proceeded to eat lunch prior to making another dive. The group, consisting of five students and an instructor, commenced the second dive holding hands to prevent separation. The plan for the dive was to proceed to a point where the bottom dropped off sharply and surface prior to heading back in to shore. The group proceeded to the drop off but, in the low visibility became confused as to whether it was in fact, time to surface. At this point the group became separated. The instructor signalled for the group to surface and inflated one of his student's flotation vests to aid in

this effort. However, by this time the rest of the group started going over the edge of the drop off and encountered a stand of trees which resulted in the hand hold system falling apart. The group then proceeded rapidly to the surface and ascertained that they were in fact one diver short. The victim's buddy was quoted when relating the incident as saying, "we were holding hands and there were a lot of trees and logs that we were falling against. I hit a tree and it knocked me away from her." The victim's body was recovered several days later by a team of Navy divers who were in the area making an underwater survey.

The cold and relatively hazardous environment contributed to this fatality. Compounding this was the all night bus ride which increased the fatique of the students. The victim was clearly too inexperienced to handle the emergency. Not only was she in poor health but, she was also over weighted and was not adequately familiar with her equipment. She still had air left in her tank when her body was located as she had failed to activate her reserve. She also had made no attempt to ditch her weight belt which made her heavier the deeper that she sank. The important aspect of this case is that at some point the victim had two or three minutes left to do something to save herself. She could have ditched her gear and made a free ascent 30 feet to the surface relying on the buoyancy of her wetsuit. However, lack of knowledge about her equipment and the high stress factor involved in the environmental conditions prevented the victim from performing the functions instinctive in a more experienced diver. This is a pattern repeated in numerous training fatalities. The only solution is for the instructor to take this into account and make every effort not to put their students in a compromising position, especially during the first few dives.

Buddy lines might have prevented separation of the students, a buoy line

to the surface could have been used for each pair of divers. Then, in case of an emergency, the instructor could have descended down the buoyline and located a student in difficulty.

The independent factors of this case did not necessarily point to a hazardous dive, but their combination resulted in a fatal situation. Instructors must recognize these circumstances and react accordingly with sound safety precautions.

Another particularily hazardous training environment is that of the rock quarry. This is evidenced when it is considered that 20% of all the quarry fatalities were students in a formal training situation. Training fatalities, when compared to overall non-professional scuba fatalities are only 11% of the total. That gives this statistic an even greater impact. The problem seems to be particularly acute in Virginia. As stated in Table 3-4, Virginia had six training fatalities. This is a state with large bodies of moderately temperate salt water. Yet, five of these deaths occurred while students were obtaining open water experience in rock quarries. Only one of the five deaths was in water above 45 degrees. However, in none of the fatalities can quarry diving as a diving environment be pinpointed as the major cause of the accident.

One of the cases does point out how the quarry location is nevertheless a contributory factor. The victim was a 25 year old male on his second open water dive at a quarry which in a three month period was the locale for two training fatalities. The exercise in which the student was participating consisted of a surface snorkel to a point above a platform which was suspended at a depth of 35 feet. The depth of the water at this point was 85 feet. Once above the platform the student, who was accompanied by an assistant instructor and an observer, was to switch to his scuba tank and descend

to the platform where two instructors would practice buddy breathing and mask clearing drills. The three divers descended rather slowly as all had difficulties equalizing the pressure in their ears. Upon reaching the platform the victim performed the exercise well and was transferred back to the custody of the assistant instructor and the observer who were to accompany him in a buddy breathing ascent to the surface. The assistant and the victim swam off the platform and started buddy breathing. At this point, the observer noted that the pair while concentrating on the buddy breathing were actually descending. The observer signalled the assistant instructor and he started kicking in order to begin the actual ascent. By this time the victim was having trouble taking the assistant's mouth piece. He began shaking violently and paniced, struggling to get out of the grasp of the instructor. The situation worsened as the assistant momentarily blacked out but, fortunately, managed to retrieve his mouth piece and make it to the surface. Upon reaching the surface the assistant asked the observer (who had surfaced earlier due to continued inability to clear her ears) if she had seen the victim. After receiving a negative reply the assistant dove again without the observer in an attempt to locate the victim. Meanwhile the two instructors noticed a small stream of bubbles coming from beneath the platform and one proceeded to the bottom to search for what he believed was a lost weight belt. As the instructor was feeling about the mud and silt in two foot visibility he felt a body. The victim was by now unconscious but, the instructor managed to get the victim to the surface. The victim received brief treatment at a recompression chamber but, in fact, was probably dead on arrival.

There were various problems in this case that resulted in one and very nearly a second fatality. The obvious drawback to the suspended platform was the unanticipated descent by the student and assistant during the buddy

breathing exercise. Had they been on a firm bottom at this depth this death may not have occurred. The cold water and low visibility probably heightened the victim's anxiety which ultimately resulted in a panic situation. Buddy breathing ascents are a high-risk exercise which in this case, when combined with the diving environment, proved too much for the student. The student was apparently overweighted for the depth of this dive. In this case, this was the primary cause of his death. In addition to this the buddy system was violated which almost resulted in a multiple fatality.

The six fatalities that occurred in swimming pools were due to a variety of causes. One student died of an air embolism following a drill in which each student proceeded along the bottom at a 16 foot depth and breathed air from six tanks placed along the bottom. The student after breathing from the fifth tank, surfaced without exhaling and remarked, "I goofed. I forgot to exhale." He then swam to the pool gutter and collapsed. He died later at a hospital. Free ascent training is a matter of considerable debate within the training agencies and will be discussed in detail later in this paper.

Another swimming pool death was also the result of a student's failure to successfully complete an instructor's exercise. In this case, the class was in the process of going through a simulated night dive during which the lighting in the pool was turned off. Two other students noticed the victim, a 50 year old male, lying on the bottom and they offered him their air but received no response. As the victim's regulator was out of his mouth, the students ascertained something was wrong and notified their instructor. The victim was DOA.

It could be argued that in these cases the exercise had the best of intentions and was a valuable learning experience for the class, but in these instances, the student's inadequate performance resulted in their

deaths. Whether or not the particular exercises were too difficult for most students is not the question at issue. The problem is that instructors must know the limitations of their weakest student and adjust their course curriculum to safely accomodate that student. To not do this obviously can lead to a fatality.

Another of the swimming pool fatalities was a direct result of inadequate supervision. The victim was practicing with two fellow students, a husband and wife, without any instructors in the immediate vicinity of the pool. The wife experienced difficulties and the victim, a 27 year old male, came to her aid and assisted in removing her from the pool. This was not an easy task for the victim and required a good deal of exertion on his part. He looked up at the husband who was preoccupied attending to his wife. The victim then waved to the couple and promptly sank to the bottom of the pool. The husband continued to aid his wife but soon noticed the victim on the bottom and jumped into the pool and brought the victim to the surface. The husband applied mouth to mouth resuscitation but the victim had already expired.

The other pool deaths were for a variety of reasons, none of which indicated any unusual circumstances.

Table 4-2 gives data on the platform utilized in training fatalities.

Table 4-2

Type of Diving Platform

Platform Year	1970	1971	1972	1973	1974	1975	1976	Per Cent
Shore	5	9	11	6	12	14	9	65
Boat	2	1	1	5	4	5	4	24
Pool	2	0	1	1	1	1	0	8
Unknown	1	0	0	0	0	2	0	3
Totals	10	10	13	12	17	22	13	100

An analysis of platforms used in training fatalities reveals that an upward trend has occurred since 1972 in the number of training fatalities that have occurred while a boat was used as the diving platform. 24% of the training fatalities happened while a boat was the platform. The most interesting aspect of the boat fatalities is that 70% of the deaths occurred while the victims were making dives deeper than 40 feet. Of these cases that involved dives in excess of 40 feet, four were documented as advanced courses. Depth limitations for advanced courses vary from agency to agency. For example, PADI's maximum depth for advanced courses is 100 feet while NAUI has a 130 foot limit. The accepted limit for scuba diving is generally 130 feet, a figure based on the criteria set forth in the U.S. Navy Diving Manual. Deducting the advanced students from the 70% figure still leaves a total of 52% of the boat fatalities occurring at depths greater than the maximum guidelines as established by the training agencies.

Of the fatalities that occurred in depths greater than 40 feet while a boat was used as the diving platform, nine of these deaths, 60%, would most likely not have occurred if the dives had taken place at depths within the established guidelines. This is admittedly a subjective statistic which is based on case analysis and deductions by the writer, however, a representative case will illustrate how such a conclusion can be made.

The victim was a 19 year old male who was participating in an advanced course held at a fresh water lake. The water was cold and visibility very limited. The dive plan was for each pair of divers to make a bounce dive to 120 feet. A bounce dive consists of a descent to the desired depth followed immediately by an ascent to the surface. The victim was in the second group of divers. As the pair was making their descent and had arrived at 100 feet the victim's buddy's regulator malfunctioned and buddy breathing

was initiated. This was done for four exchanges when the buddy paniced and made an emergency ascent to the surface independently. The buddy was hospitalized and fortunately survived. The victim though was not as lucky and failed to surface. His body was recovered one month later by a manned underwater submersible.

Besides reaffirming the difficulty of successfully completing a buddy breathing ascent, this case is a good example of why not to have students make deep dives. Had this dive been made to 40 feet and a breakdown in the buddy breathing occurred, the victim would have a more feasible chance to make a successful independent swimming ascent. Of the nine cases using boats as a platform and excessive depth was a factor, two thirds of the cases involved unsuccessful attempts at making buddy breathing ascents.

Analysis of diving platforms used in training fatalities shows a potentially dangerous trend developing. There is definitely an increase in the use of boats as diving platforms in training fatalities. Furthermore, training dives using boats appear to be more likely to involve dives to excessive depths. To the student diver this presents an especially acute problem should an emergency at depth arise. That two thirds of the attempts at buddy breathing ascents were unsuccessful is an indication of the severity of the problem. Instructors need to be more cognizant about the effects of excessive depths on their student's chances to successfully utilize emergency procedures especially when the tendency exists to make deeper dives when using a boat as the diving platform.

Diving to excessive depths is not only a problem when diving from boats. Table 4-3 lists the depths at which the training fatalities occurred.

Table 4-3

Depth of Training Fatality Dives

Depth in Feet Year	1970	1971	1972	1973	1974	1975	1976
0 -10	3	0	3	2	3	5	1
10-20	1	1	2	1	2	3	1
20-30	4	1	2	1	2	1	4
30-40	0	1	0	0	3	4	2
40-50	0	0	1	0	2	1	1
50-60	1	2	0	5	2	1	0
60-70	1	2	2	1	1	1	1
70-80	0	1	0	0	0	1	0
80-100	0	2	1	1	1	1	0
100-130	0	0	0	1	0	1	1
Depth Unknown	0	0	2	0	1	3	2
Totals	10	10	13	12	17	22	13

Thirty six training fatalities occurred at depths greater than the maximum allowable 40 foot depth for basic scuba courses. Of these thirty six deaths, six involved students participating in advanced classes. This still leaves 31% of the training fatalities occurring at depths in excess of the recommended limits. In 1/3 of the fatalities that involved dives deeper than 40 feet, unsuccessful attempts at buddy breathing were initiated, another statistic indicating the difficulty novice divers have in completing this means of emergency ascent. For an instructor to assume that this means of ascent is a viable option for a student diving deeper than forty feet is questionable.

A fatality which points out questionable judgement involved both a dive

to excessive depths and the failure of an attempted buddy breathing ascent. The victim was a 19 year old male making his fourth open water dive. It was the intention of the instructor to allow the students to make a dive to 100 feet. His rationale was, "We always give students a 100 foot dive since sooner or later they are going to do it anyway." On the day in question, the instructor could not attend the open water dive as a representative from a diving equipment company was visiting his dive shop. In his place the instructor dispatched a diver who worked for him as an assistant instructor but lacked certification as an instructor by a national agency even though he was "personally certified" by the instructor who ran the diving shop. After making the descent to 100 feet the victim and his partner, who was a student instructor, began their ascent. At a depth of around 50 feet the victim ran out of air and began buddy breathing. The ascent was temporarily halted as the student instructor signalled his other students to ascend to the surface. When the student instructor turned his attention back to the victim he noticed that the victim had begun drifting back towards the bottom. The student instructor began a descent in order to catch up with the victim but he too ran out of air before he could catch up with his student. The student instructor was forced to surface. The victim understandably failed to surface. His body was recovered the next day.

Diving to excessive depth which places the student diver in a compromising situation should he run out of air or have an equipment failure, be it real or imaginary, has accounted for a significant number of training fatalities. There is really little value in making deep dives. The skill involved in descending is minimal. If a diver can equalize his ear pressure to descend down to 40 feet he can usually make it much deeper with little additional effort. Once depth is reached there is really very little to do

due to the radically decreased air supply - at 130 feet a diver would have approximately one fifth the usable air that he would have near the surface. Furthermore, anxiety on the part of the student may cause him to overbreathe his regulator since denser air - caused by the increased ambient pressure - increases respiratory work. If this is combined with poorly maintained regulators, the anxiety ridden student, as happened in several cases, imagines that he or she is in fact out of air. At this point the novice diver may panic, making a successful emergency ascent to the surface difficult at best, even though the student in reality has enough air remaining on the ascent due to the decrease in ambient pressure to get a few breaths out of their tank.[26] To make a safe emergency ascent the diver must possess the utmost in skill, calmness, and coordination - attributes which are greatly inhibited by excessive depth. In a recreational training environment there is no need to have novice divers make deep dives. Water less than 40 feet can present enough challenges for a diver to acquire sufficient experience and skill in diving. For instructors to take basic students to greater depths presents significant problems as evidenced by the fact that 37% of the training deaths occurred while students were diving deeper than 40 feet.

Part V

Causes of Recreational Training Fatalities

The proximate causes of training fatalities are listed in Table 5-1. The intent of this particular table is not to present undisputable statistical data. An analysis of this sort inevitably requires some subjectivity. The proximate starting causes are sometimes difficult to ascertain for various reasons such as limited data available to make a completely objective

opinion based solely on the facts available. In many cases the starting cause of an accident may in fact be one of several causitive factors that ultimately resulted in the victim's demise.

An example of a case involving several causitive factors involved a 29 year old male who had been "out on the town" the night before and got only four hours sleep prior to his dive. In addition, the man was taking quaaludes "for gall bladder trouble." The instructor noted that the victim was acting "funny" and had the student go into the water without tanks to see if he would become alert enough to dive. The instructor then decided that the victim was alert enough and the class proceeded with the dive. In the course of the dive the victim became separated from his buddy and ended up tangled in a kelp bed and eventually ran out of air and drowned. Which factor resulted in the victim's death? Was it the victim's physical state, or the fact that be became tangled in the kelp? Or was it the fact that he ran out of air? Each choice has some validity but in this case the victim's poor physical condition due to the alcohol and drugs was selected as the starting cause, the only fatality in this study in which drugs or alcohol were a factor. The importance of Table 5-1 therefore, lies not in the precise statistical data of the table, but rather the ability to identify the major causitive factors which lead to training fatalities.

Table 5-1

Proximate Starting Cause of Fatalities

CAUSES	1970	1971	1972	1973	1974	1975	1976	TOTAL	PerCent
MEDICAL AND PSYCHOLOGICAL									
Overall fatigue	2	0	4	1	2	3	1	13	13
Excessive stress (Panic)	1	4	1	1	1	1	1	10	10
Heart Failure	2	1	1	0	1	0	1	6	6
Miscellaneous	1	0	0	1	1	2	1	6	6
							subtotal	35	35
BUDDY SYSTEM FAILURE									
Separated or Diving alone	0	0	1	0	5	4	1	11	11
RUNNING OUT OF AIR									
No air situation	1	1	2	1	1	4	2	12	12
ASCENT DIFFICULTIES									
Emergency ascent training, Buddy breathing failure, Emergency ascent	1	8	1	2	2	2	2	18	18
DANGEROUS ENVIRONMENT									
High surf, cold water, low visibility	0	0	2	0	2	0	0	4	4
Kelp entanglement	0	0	0	0	1	0	1	2	2
Excessive depth	0	2	0	1	1	1	0	5	5
							subtotal	11	11
EQUIPMENT MALFUNCTION									
Regulator failure, over-weighted, unfamiliarity with diving gear	0	1	0	2	0	2	2	7	7
UNDETERMINED	2	1	1	3	0	4	1	12	12
TOTALS	10	10	13	12	17	22	13	97	100

The most prevalent causitive factor was the medical and psychological category which accounted for 35 cases (36%). Within this category most of the deaths were the result of fatigue, usually involving divers over 35 years of age. A typical case of this type involved a 45 year old male who had surfaced following a dive and was proceeding to his dive mat with his buddy. On the swim back to the mats they encountered a series of three kelp beds which required considerable exertion on the part of the victim to cross. The victim finally managed to reach his mat but was unable to pull himself out of the water due to his fatigued state and the fact that he had swallowed considerable water while crossing the kelp beds. At this point, the victim's buddy decided to tow him in to shore and proceeded in towards the beach. But by the time they got in the victim had aspirated his stomach contents and resuscitative efforts were to no avail.

Many of the fatigue fatalities would not have occurred had the victims saved sufficient air for the surface. Breathing from a regulator instead of a snorkel on the swim in to the beach is much easier and more relaxing for a fatigued diver. In other cases involving kelp entanglement on the surface and relatively high surf at the surf line, major problems for a fatigued novice diver would have been alleviated had the diver still had air remaining in his or her tank.

As noted in the table, 6 fatalities were diagnosed as heart attacks. Physical exams are not required, but are strongly recommended for people over 40, for participation in a scuba course. Several of the heart attack victims had had physicals prior to their death and had received the go ahead from their physicians to dive. Requiring physicals for divers over 40 will not be a universal panacea but it definitely could reduce some fatalities by discouraging some potential divers from diving due to poor

Table 5-2

Buddy Activity

YEAR	1970	1971	1972	1973	1974	1975	1976
Buddy stayed with victim	1	3	5	2	1	7	6
Victim surfaced before buddy	1	2	0	1	0	3	0
Buddy surfaced before victim	1	2	0	1	0	3	2
Buddy and victim separated under water	0	2	4	2	9	5	3
Buddy and victim separated on surface	2	1	2	2	4	1	1
No buddy	2	0	0	1	2	0	1
Buddy system not in use	2	0	2	2	1	1	0
Unknown	1	0	0	1	0	2	0
Totals	10	10	13	12	17	22	13

physical condition.

One of the primary tenets of scuba diving involves the theory that divers should never dive alone. The use of a partner or "buddy" when diving enables a dive team to increase their chances of successfully responding to an emergency situation. "Never dive alone" is probably the most oft repeated phrase encountered in a scuba course. However, as Table 5-2 shows, diving alone is not the biggest problem but rather, the problem is that divers lose track of each other during the course of a dive and when an emergency situation arises they are unable to help each other.

In only 25 of the 97 training fatalities did the victim actually stay with his buddy. Subtracting the six deaths that were multiple fatalities, there were only 19 cases (20%) in which the buddy system was in use and the system did not break down. In 54 cases (56%) the divers were either voluntarily or involuntarily separated. If a buddy were close by in many of these cases the fatalities may not have occurred.

The reasons for buddies becoming separated are numerous as an examination of several cases illustrates. One case concerned a 23 year old male who was on a training dive with his class which included his girlfriend. During the class dive the victim's girlfriend ran out of air and commenced buddy breathing with the victim. For an unknown reason this did not work out and she started buddy breathing with another student. According to the girlfriend, the victim then "got mad" and swam away alone. He was not seen alive again. His body was recovered the next day with 500 psi of air remaining. What happened after the separation that resulted in the victim's death is a matter of speculation as is the question of why the victim got mad enough to swim off by himself.

Another case involved a 37 year old male enrolled in an advanced course.

He reportedly was a veteran of over 800 dives. According to class members the victim voiced his desire to look for scallops before they commenced their dive. During the dive the victim left the group, presumably to look for scallops, and was not seen again. His body was never recovered.

The high percentage of training fatalities that occurred following the separation of buddies indicates the need to ensure that all students are taught the skills and importance of maintaining contact with their buddy in the course of a dive. Another oft repeated diving axiom is that diving alone does not kill divers, but being alone when something goes wrong does. The statistics in Table 5-2 bear out the sagacity of that particular saying.

Running out of air or being in a situation in which the student thought he or she was running out of air was identified as the starting cause in 12 cases. However, there were 17 cases (18%) identified in which the student believed that they ran out of air. The latter number is larger as certain cases which resulted in an out of air situation were the result of another starting cause, i.e. a student becomes tangled in kelp and runs out of air. Table 5-3 lists the actions taken by students who perceived themselves to be in an "out of air" situation.

Table 5-3

Action Taken When "Out of Air"

Action Taken	Number of Cases
Victim failed to surface-Found Later	7
Ran out of Air on Surface-Drowned	5
Attempted Buddy Breathing-Ascent to Surface	4
Independent Ascent to Surface	1
Total Cases	17

Several observations on this table are important. First, only one fatality involved an attempted emergency independent ascent to the surface. When actually out of air this is a recommended means of making an emergency ascent.[27] The low number of fatalities involving independent ascents would seem to validate the selection of this means of emergency ascent as the recommended choice. Another noteworthy item is that in 23% of these cases the victim had sufficient air remaining had he or she successfully activated their reserve air supply. In most of these cases a student is at the end of a dive and is usually cold and breathing rapidly when it suddenly becomes very difficult to get a breath. In this situation the novice diver displays the tendency to panic and instead of calmly turning on the reserve they either fail to correctly activate their reserve air, or attempt some form of emergency ascent to the surface. This is unfortunate because as previously discussed, the decrease in ambient pressure can result in a few breaths of air being available to the student should they have the presence of mind to realize it.

That five fatalities in the "out of air" category occurred to divers on the surface again indicates the need to emphasize that as good diving practice, students should save sufficient air (300 - 600 psi) for the surface.

Ascent difficulties were the starting cause for ten fatalities. Of these ten fatalities seven occurred while the students were participating in emergency ascent drills. Table 5-4 gives a breakdown of these fatalities on a year by year basis. A typical case in this category was one in which a 21 year old male was on his second dive in open water and the class was conducting independent emergency ascent training from 25 feet. The procedure was that the instructor would grab a hold of each

student and give the signal to start the ascent. The instructor would hold on to the student through the ascent and, upon reaching the surface, the instructor would critique the student. In this instance, the instructor and victim made their ascent and upon reaching the surface the instructor asked the victim if he was all right. The victim replied, "I'm fine." The instructor was just about to tell the victim how well he had done when the victim threw his head back, made a "strange gurgling noise" and started to sink. The student was evacuated by helicopter but died in a hospital from an air embolism.

Emergency ascent training is perhaps the most hotly debated issue in recreational scuba training today. The primary danger being that it exposes students to the danger of an air embolism, a condition which is frequently fatal. Air embolisms occur when the tiny air sacs in the lungs, called alveoli, rupture which allows air to escape. Rupture of the alveoli may admit air bubbles into the lung capillaries; from there they enter the heart and are pumped out through the aorta. These air emboli can obstruct blood flow in the brain and/or coronary arteries. Air embolisms are often fatal because effective treatment requires prompt recompression which may not be readily available.[28]

For years all major training agencies required open water emergency ascent training prior to basic certification. However, in 1976 the YMCA broke with tradition and prohibited its instructors from conducting actual continuous exhalation ascents from depths greater than 12 feet.[29] The situation was clarified somewhat by the National Scuba Training Committee (formerly the National Scuba Training Council - but still the NSTC) which met soon after it appeared that a serious problem existed as to the future viability of emergency ascent training. Briefly, there were two schools of

thought on emergency ascent training. One school felt that due to the fatalities that had occurred while emergency ascent training was being conducted the students should not be exposed to the hazards of a potential air embolism and the drills should be simulated. In this case students would perform simulated ascents while actually swimming horizontally. The counter argument was that running out of air or a similar equipment failure was a real possibility when scuba diving and students should be proficient in the ability to perform emergency ascents in order that they can successfully handle such an emergency.

The NSTC policy statement actually skirts the basic question of how to conduct emergency ascent training. The policy statement defines the emergency options available to a diver with an apparent termination of air supply at depth. These options consist of the use of an extra second stage regulator (octopus), buddy breathing ascent, emergency swimming ascent, or buoy any ascent. The statement says that it is the responsibility of each agency to train divers to select the appropriate option for the situation and to train the diver to be capable of performing the options.[30] The policy statement does not specify how the training is to be conducted.

Ascent training remains a problem area. Buddy breathing is recognized to be a very hazardous method of emergency ascent. According to NAUI it is the least desirable method of making an emergency ascent.[31] Thirteen such fatalities involving student in a training situation occurred. Table 5-5 lists the problems encountered during these ascents.

That only one of the 13 fatalities occurred while an octopus rig was being used indicates the desirability of the use of an additional second stage. Some training agencies strongly recommend that their instructors be equipped with an octopus. The major training agencies concur that the

preferred method of emergency ascent is the independent swimming ascent.

Data from tables 5-4 and 5-5 confirm the difficulty involved in teaching students the requisite skills necessary to perform successful emergency ascents. The recent concern over ascent training has resulted in workshops on the subject, such as one held in November of 1977 sponsored by the Undersea Medical Society. The one issue that all concerned appear to agree upon is that more research must be done prior to any concrete solution. In the interim the training agencies will refine and tighten the procedures utilized in conducting emergency ascent training arguing that, "the benefits of the training outweigh the risks if the training is properly conducted."[32]

Table 5-4

Emergency Ascent Fatalities

YEAR	NUMBER
1970	1
1971	0
1972	1
1973	0
1974	1
1975	2
1976	2
Total	7

However, due to the high skill factor involved in learning emergency ascent skills and the unique dangers presented by the changing ambient pressure, it is likely that fatalities while conducting emergency ascent training will continue. A possible alternative, not teaching emergency ascent training skills, could lead to an even greater loss of life as divers are certified without the most rudimentary ability to confront emergencies

Table 5-5

Problems During Buddy Breathing Ascents

CASE	NUMBER
Attempt aborted, changed to swimming ascent	4
Victim paniced and refused air	1
Victim unable to breathe and subsequent panic	4
Double fatality	1
Donor out of air	1
Successful ascent, victim died on surface	1
Octopus	1
Total	13

underwater.

Dangerous environmental conditions accounted for 11 cases (11%) of the fatalities. The most important factor is the tendency to make dives to an excessive depth which is been discussed previously. The one thing that instructors need to be more aware of is that even though such environmental conditions such as 3 foot surf may not seem dangerous to them, it can cause enough apprehension on the part of a student to result in a fatality.

Equipment failures were a relatively minor cause for training fatalities resulting in only 7% of the deaths. Of these deaths, there were only two documented cases of regulator failure. Most of these cases in this category were from the victim being overweighted which frequently caused the victim to panic in the face of adversity.

Autopsies were conducted in 64% of the fatalities. The results are documented in Table 5-6. When comparing Table 5-6 with the corresponding total recreational fatalities, the major difference is that lung overpressure is

the primary complaint more often in training fatalities, 26% vs. 18%.[33]

Table 5-6

Results of Autopsies

PRIMARY COMPLAINT	1970	1971	1972	1973	1974	1975	1976	TOTAL
Asphyxiation or drowning	3	1	8	3	5	8	6	34
Lung overpressure - Air embolism or pneumothorax	2	2	1	3	2	4	2	16
Heart failure	2	1	1	0	1	0	1	6
Aspiration of stomach contents	0	0	1	1	1	0	0	3
Bilateral ear rupture	0	0	0	0	1	0	0	1
Intestinal disorder	0	0	0	0	1	0	0	1
Gas contamination (CO poisoning)	0	0	0	0	0	1	0	1
Autopsy not conducted/ Body never recovered	3	6	2	5	6	9	4	35
Totals	10	10	13	12	17	22	13	97

Part VI

Conclusions and Recommendations

Recreational diving instruction has been riding a boom for the last ten years. During this time there has been a rapid expansion in the number of new divers certified by the major national training agencies. And there also has been no regulation of the training community by any federal or state regulatory agency.

All attempts at diver training regulation have been at the local level of government, such as the Los Angeles County Scuba Ordinance which went into effect on October 15, 1974. While the commercial diving industry came

under strict regulation by the Occupational Safety and Health Administration (OSHA), which established mandatory guidelines effective October 20, 1977, the training of recreational scuba divers managed to be one of the three exemptions to the OSHA diving standards.[34] Lack of government regulation might lead one to believe that the training agencies are doing their job well and any attempts at regulation would be classified as more "needless government interference." This paper has shown people do indeed die while learning to scuba dive and a significant portion of these deaths could be prevented. The issue is whether or not outside regulation of the industry would be able to prevent these fatalities. It is the opinion of the author that strict federal guidelines regulating scuba course minimum requirements and standards for instructors would eliminate a portion of the training deaths. However, a preferable solution - at least to the training agencies - exists. Namely, concrete measures that can be mutually agreed upon standards, taken by the training agencies which would result in well trained divers taught by competent, professional instructors.

In the last ten years many divers have been certified by the national agencies but a smaller number of these divers actively engage in the sport following certification. Various estimates are available that indicate that anywhere from 45 to 90 percent of all certified divers stop actively diving within one year of completion of their basic scuba class.[35] For the training agencies to continue to train a high number of divers, they eventually must attempt to encourage inactive divers to take more advanced courses. Only 5% of certified divers currently take any kind of an advanced course.[36] The reason for the lack of sustained interest in scuba diving by students is that divers are inadequately trained. The vast majority of scuba students receive only three open water experiences, only

two of which involve the use of scuba gear. It is impossible to teach a person to be a proficient diver, void of the normal fear and anxiety associated with venturing into a foreign environment, in such a limited time frame. The training agencies recognize this and universally encourage more open water dives for students. They offer advanced designations such as "Open Water Diver" to students in the hope that they will obtain the necessary skill levels and exposure to open water that will enable them to feel completely familiar with their equipment and in control of their experience underwater. These are skills that all scuba divers should have before they receive certification and are able to dive independently.

Training agencies are in the process of changing their curriculums. PADI now promotes "an ultramodern, nontraditional way to teach diving." In the interests of a more realistic experience, "all water work for the course should be conducted in open water, under favorable conditions." But the new course still only requires three open water training dives, although the preferred Open Water Scuba Diver, which includes five open water dives, course may be taught.[37] The new course that requires five open water dives is an improvement but eliminating pool training may increase the apprehension the student is likely to experience in his first dives. A better approach might be to require five open water dives in addition to pool training. As the study of training fatalities has shown, students need all the time they can possibly get, be it in a pool, ocean or classroom.

Understandably, one training agency is reluctant to require a basic course that consists of more open water diving than the other training agencies. Diver training is a competitive industry not without certain financial considerations. The potential student represents a capital gain to both the instructor and frequently the dive shop with which the instructor

affiliates.

In addition to more open water training, the training agencies need to place more emphasis on having their students acquire the practical open water skills that they will need to feel comfortable and confident underwater. The training fatality statistics indicate that frequently students are unable to handle emergencies underwater. Students are often unable to handle out of air situations, staying together with their buddy during the course of a dive, properly using their equipment. These are rudimentary skills which students must have the ability to utilize if they are to be competent divers.

Conscientious and knowledgable instructors are necessary if the training agencies are to reduce training fatalities. It is in the instructor's own best interests to practice what he teaches. Legal precedents have been established that dictate that:

> A scuba instructor may be held liable for negligence in failing to exercise the ordinary skill of his profession which results in the instruction and supervision of students in learning scuba diving and for any injuries incident to that instruction.[38]

The legal profession since 1971 has found instructors negligent and considerable judgements have been awarded to the plaintiffs. In fact there is a shortage of insurance companies willing to write liability coverage for the training industry which was very close to not securing insurance coverage in 1977.[39]

Instructors need to know when not to make training dives. This study has shown that instructors need to pay more attention to adverse environmental conditions and the effect these conditions have on the anxiety level of inexperienced divers. Too many students were unable to cope with the increased demands placed on them by the hazardous locations where they were diving.

Instructors also show the need to learn better how to gauge the limitations of their students. It appears that instructors attempt to rush some of their students and have them perform exercises which exceed their ability level. This has resulted in several deaths.

Certain requirements can be made mandatory by the training agencies in order to reduce fatalities. A comprehensive physical examination should be required for students over 35. The physical examination should make an accurate assessment of the potential student's ability to engage in relatively strenuous periods of exertion.

The training agencies should also investigate the possibility that changes in scuba courses which are held in cold water are in order. That the majority of trainees died in cold water, often accompanied by low visibility, indicates the need for more research in this area.

People will continue to die while learning to scuba dive. The underwater environment does not provide the opportunity for many mistakes. Students will always be nervous and liable to make a fatal error.

Government regulation could reduce training fatalities through rigid criteria imposed upon the training industry. However, the same goal can be accomplished by self regulation of the training agencies by a strong advisory board such as the NSTC. This body could enforce uniform guidelines that would permit the "basic" scuba diver to be adequately trained. If each of the major training agencies would consent to abide by the dictums of such a body the competitive aspects of training recreational divers could assume a more positive direction - namely train a better diver.

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