1. Introduction

The Salvage Officer confronted with the task of retrieving a sunken or stranded submarine will need to draw heavily upon previous submarine salvage operations. Most likely he will not have had personal experience in this field, and will therefore need background information which will prepare him for his particular salvage problem and provide a basis for a modus operandi.

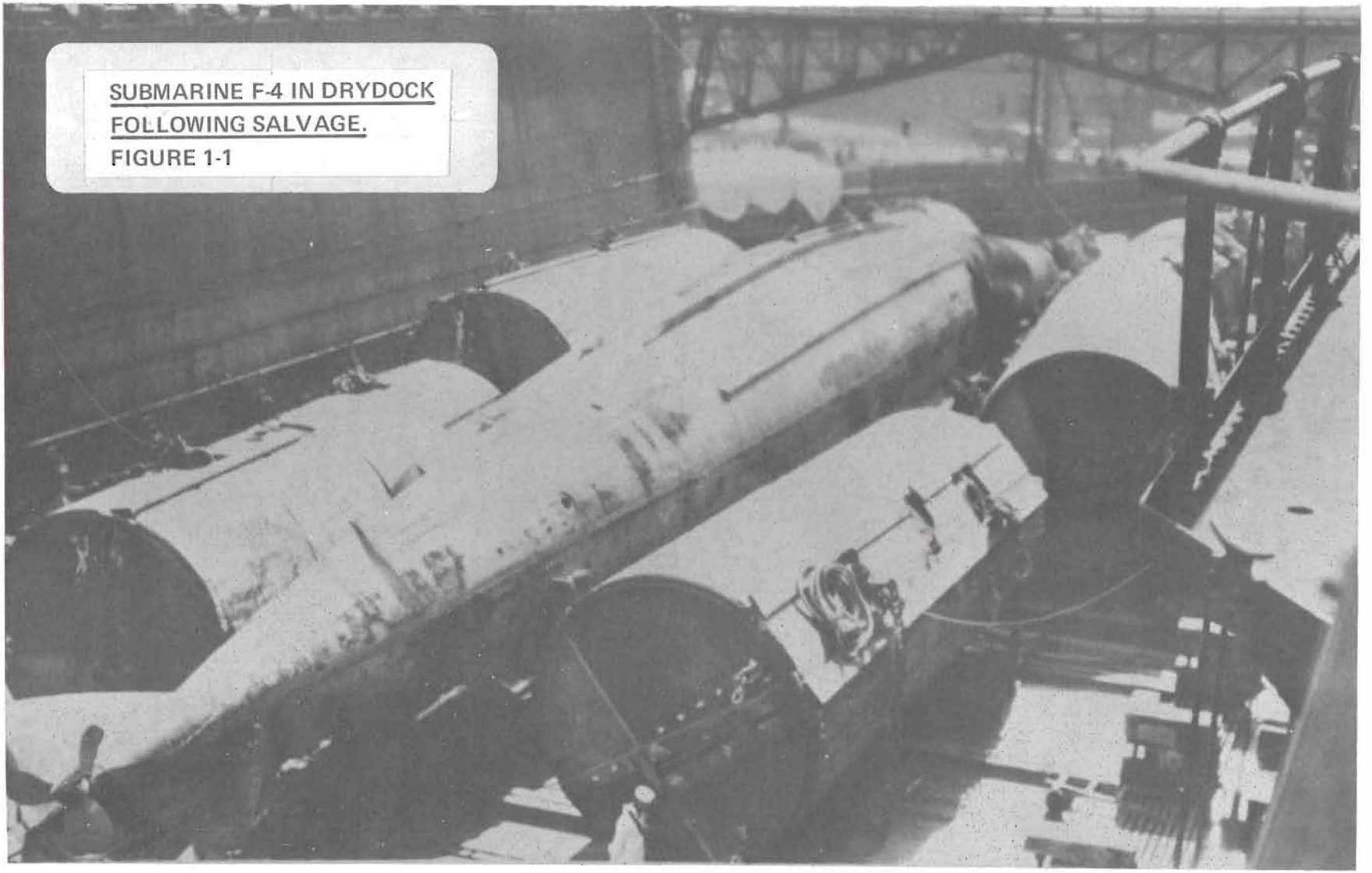
Every submarine salvage operation has different circumstances, depending upon the size of the submarine, its position, flooded condition and depth, and the type of bottom on which it rests. The review of past submarine salvage operations given in the Appendices to this manual, may assist the Salvage Officer in estimating the requirements for his job and in anticipating some of the problems that may arise.

There have been approximately twenty three submarine losses of non-combatant nature in the US NAVY. Of these, ten occurred in such deep water that salvage could not be attempted. Out of the remaining eleven, six were in shallow water or under conditions that made salvage relatively simple; however, of the other five submarine salvage attempts in deep water, four were successful.

The first operation was the raising of USS F-4 off Honolulu harbor in 1915. The submarine had to be brought up from a depth of 306 feet; to date, the deepest salvage ever completed. Divers had to work at depths far exceeding the limits which had been reached in that day. However, in comparison with later salvage operations, it must be remembered that F-4 was small, displacing only 400 tons, and considerably easier to handle than S-51 at 876 tons and SQUALUS at 1450 tons.

The submarine service was not prepared for such disasters as F-4. The deepest a diver had gone was 274 feet and little was known about the effects of decompression sickness or other physiological aspects of diving. There were no rescue or salvage vessels fitted out for recovering crews or submarines.

F-4's salvage force consisted of chartered tugs, two decked-over scows with improvised windlasses for lifting, and a diving lighter with a recompression chamber. The method of bringing the submarine into shallower water was by sweeping wire cables and chain slings under the hull, lifting with the scows, and then towing until the submarine grounded. A second purchase would then be taken on the hoisting cables and the process repeated.



SUBMARINE F-4 IN DRYDOCK FOLLOWING SALVAGE.
FIGURE 1-1

S-4 UNDER TOW ARRIVING AT THE BOSTON NAVY YARD.
FIGURE 1-2

The operation was attended by all of the adverse elements normally associated with underwater salvage; failure of equipment, accidents, and bad weather conditions slowed the job considerably. After weeks of lifting and towing, the wreck was finally hauled into shallow water, at which time a sudden onset of heavy swells carried away all of the lifting slings and severely damaged the submarine. The action of the sea had sawed the cables and chain slings nearly through the hull, making further lift by the scows impracticable. It was feared that the hull would be cut entirely in two, or that the bow section would sag out of the slings and ground in the harbor. The first submersible pontoons were designed and built to suit the condition of F-4, and to bring her to the surface without further damage.

Perhaps the most significant salvage of a submarine was that of S-51. Prior to this achievement by the NAVY, an unsuccessful attempt had been made to salve S-5.

The salvage problems in these two cases were quite similar as to depth of water, size of the submarine, character of the bottom, availability of qualified divers, and the availability of a suitable salvage vessel and other salvage equipment. S-51 was completely flooded, whereas S-5 had only one main compartment flooded with little if any water in the other compartments. S-5 was rigged for dive, all compartments were intact, and all bulkheads secured. S-51 was rigged for surface, the hull had been opened by collision, and none of the bulkheads was watertight. Both sites were exposed to the open sea, and although S-51 had somewhat better protection from winds than S-5, this difference in exposure was not great insofar as its effect on salvage operations was concerned.

The salvage of S-5 was undertaken with a preconceived notion that the submersible pontoons, which were available in sufficient quantity, could not be used in the open sea. This assumption apparently extended to any form of external lifting force and led to a salvage plan which included only self-lift and required removal of the water from all compartments and large tanks. There were no air salvage connections, so it was necessary to provide spill pipes and air connections for the compartments that were to be dewatered. In preparing the compartments for blowing down, explosives, which were used for cutting and for removal of hatches, caused damage that eventually led to abandonment of the salvage attempt. Utilizing hindsight, it seems clear that the decision to attempt the salvage without any external lift was responsible for failure to recover the submarine. When the salvage began, S-5 was in the most favorable condition of any of the five deepwater salvages that the US NAVY has undertaken. In the other four cases, external

S-51 SUPPORTED BY PONTOONS UNDER TOW AFTER SUCCESSFUL SALVAGE.
FIGURE 1-3

lift was included in the salvage plan and greatly reduced the amount of work required. External lift may have been the factor that made the difference between success and failure in these attempts.

The S-51 salvage operation is of great interest because:

1. There was a well-conceived salvage plan.
2. Problems encountered were diagnosed and overcome as they occurred.
3. The salvage plan was adjusted as better information became available, and as difficulties were encountered.
4. An excellent technical report was prepared covering all features of the operation, with particular emphasis on the difficulties.
5. The salvage force was at all times confident of success even though many things seemed to be going wrong. This confidence is present in all successful salvage operations, and even the most discouraging catastrophies do not affect it. This confidence or determination to succeed is the essential part of any salvage plan.

By contrast, the raising of S-51 proved to be a valuable experience to the US NAVY. Tunneling under the submarine, using water jets supplied by a 2-1/2-inch firehose, created problems for the divers. These centered about the handling of the hose and nozzle when subjected to pressure sufficient to cut and wash away the soil on the bottom. This brought about the development of a balanced washing nozzle that speeded the tunneling required for rigging of slings. During the winter, when salvage was suspended, a new underwater cutting torch was developed, as well as a more efficient underwater light.

For the first time, actual experience was gained in calculating the suction effect of the bottom, and determining breakout force needed to overcome it. The big 80-ton pontoons were found to be extremely difficult to control when placed alongside S-51, and again, when they were on the surface knocking about in rough seas. This experience, described in the S-51 salvage report, proved valuable later when S-4 salvors prepared for their job. The pontoons were modified to make them easier to handle, based primarily on the S-51 report.

A little more than eighteen months after S-51 was salved, on 17 December 1927, another submarine disaster struck the US NAVY.

S-4 sank off Provincetown, Cape Cod, after colliding with a Coast Guard destroyer. The NAVY decided to salve the submarine even though the salvors were faced with the prospect of conducting diving operations in midwinter. The rescue vessel FALCON and many of the divers who had worked on S-51 were on hand for the job, and, consequently, the salvage work proceeded at a good rate. In the beginning, the divers had problems with air lines freezing, which caused particles of ice and snow to fly about in their helmets. This was corrected by the invention and installation of an air conditioning plant that heated the divers's air.

In many respects the raising of S-4 was similar to that of S-51. Both submarines had been sunk through collision which opened the pressure hull and flooded compartments that could not be sealed. In both cases tunneling was required to permit reeving chain slings, and the raising was done by dewatering compartments and using submersible pontoons. However, aside from the weather, the S-4 operation was easier. The excellent salvage report of S-51 and the availability of the same salvage ships, officers, crew, and divers speeded the work. The water was shallower and protected from the open sea; the new washing nozzle cut tunneling time from days to hours; the sea floor was soft and porous, and, consequently, the suction effect was negligible when breaking the wreck free of the bottom. The submersible pontoons were modified to the condition described in Chapter 5. This is the only salvage of a US submarine which was so meticulously planned that nothing serious seems to have gone wrong. It is an excellent example of the value of detailed knowledge of previous salvage operations.

The S-4 disaster occasioned a serious review by the NAVY of problems concerning submarine safety and personnel rescue. There resulted many innovations, mostly in the field of rescue devices. The tragedy of not being able to rescue trapped men at the shallow depth of 102 feet spurred the development of the Momsen escape lung and the McCann rescue chamber. This latter device was to save thirty three men of USS SQUALUS, trapped in 240 feet of water. Also, salvage air connections were installed on all compartments, main ballast tanks, and fuel oil tanks.

Other maritime nations were not without their submarine accidents as is illustrated in Table 1-1. At the time of the S-4 sinking, Britain listed fourteen submarines sunk, while France had suffered eight losses. The worst attrition rate for submarines occurred during a 24-day period in 1939. First, USS SQUALUS sank on 23 May; eight days later, HMS THETIS went down followed by the French submarine PHENIX.

Unlike S-51 and S-4, SQUALUS was raised in three stages, the first two of which were accomplished without any attempt to remove water from the flooded compartments. All lifting forces were supplied by pontoons, and ballast tanks were blown through salvage air fittings. For the third and final lift, water was removed from the main compartments and the number of pontoons reduced.

The interesting features of this operation were:

1. The salvage was accomplished in three stages.

2. Control pontoons were used to limit the distance the ship was lifted.

3. No water was removed from the main compartments while the submarine was in deep water.

4. When SQUALUS was brought to shallow water (90 feet), and the main air induction valve closed by external gagging, the compartments were pumped down. To assist the pumps against a 90-foot head of water, air pressure equal to the sea pressure was applied to the compartments. In this way, much work which had been done on the previous salvage operations to make the compartments tight against internal pressure was avoided.

5. The salvage plan adopted for SQUALUS was to minimize divers's time on the bottom in the initial deep site. Of particular interest is the fact that the submarine was rigged with pontoons and actually raised off the bottom after only 31 man-hours of diving. Although this attempt failed because of lack of control, the additional time that would have obviated this deficiency would not have exceeded one man-hour.

6. Only two locations were used for pontoon slings while the submarine was in deep water. Since the hull of SQUALUS was clear of the bottom at one of these locations, it was necessary to provide only one passage for slings through the mud. For this passage a lance was devised which was safer and required much less work by the diver than the previous tunneling method.

In the Appendices are two reports of British submarine salvage operations which reflect a different approach for recovering a wreck. These reports describe the techniques for lifting by a specially designed "lift ship" which literally hauls the submarine up from the bottom by cables at the surface.

HMS THETIS was salved employing a lift method not previously used and it required finding a suitable vessel to accomplish the task.

In almost all cases of submarine salvage, specialized equipment and material were designed specifically for the job A notable exception was the work on S-4 which was undertaken very shortly after the salvage of S-51. Generally, after each major undertaking, the salvage force was disbanded and the specialized equipment put in storage. It has been found to be too costly to maintain a large manned force in anticipation of a submarine salvage job. In salvage, time is rarely of the utmost importance; the rescue aspects in such an event have normally been concluded before the salvage force moves in.

It is difficult to forecast submarine accidents, as it is with any other disaster. The time between the sinking of S-4 and SQUALUS was twelve years. During World War II, some fifty two submarines failed to return from patrols; possibly some small portion of these were due to accidents and not through enemy action. However, if such wartime accidents did occur, they must be few in number judging from the evidence available since the war. Of the four US NAVY submarine losses following World War II, it is interesting to note that all went down in water too deep for salvage. USS COCHINO sank in 840 feet of water, USS STICKLEBACK was sunk in 9000 feet of water. USS THRESHER was lost in 8400 feet of water, and USS SCORPION in 10,000 feet of water.

What can be anticipated in water depths for a submarine salvage operation? The majority of submarine accidents occur in or near congested water routes to ports. If failure of equipment is involved, the casualty will usually occur during the first few hours underway or during the initial trim dive. These conditions tend to make the locale of a submarine casualty coincide with the shallower ocean areas.

The limiting depth from which a submarine can be salved can only be expressed in terms of the latest operational techniques in diving by men, or submersibles, and the operational availability of a lifting force to be applied to the submarine. Pontoons, lifting slings, or a water-blowing system must be attached or applied to the submarine in some manner or combination, if it is to be raised. As the depth of the sunken submarine increases, the feasibility of surface-supported diving or lifting with cables decreases. At the present time, divers still must be used to seal up compartments and to cut tunnels for necessary pontoon slings. Deep sea diving, supported from a surface salvage vessel, is the only method there is at this time for performing underwater work in salvage operations.

USS TIRU (SS 416) AGROUND AND STRANDED.
FIGURE 1-4.

The current experimentation and research in advanced diving systems employing pressurized habitats, lock-out saturated diving techniques, submersibles with diver lock-out capabilities, and the various combinations possible for deep diving will initiate some radical changes in future operations. The Salvage Officer will, of course, employ the latest operational techniques available to him.

The deep sea diver today depends directly on the surface ship to supply his breathing gas, communications and underwater tools. He is limited in depth to about 250 feet if breathing air, or 380 feet if he is on a helium-oxygen mixture. The new technique of saturation diving using the Personnel Transfer Capsule is extending diver depths to 600 feet and more. There are other limitations in diving, other than the physiological ones. Currents, even moderate ones, can drag a diver off his feet if he is in deep water, with the long scope of his life line and air hose being affected by this force. The weather conditions on the surface may prohibit diving because of the danger of the tending ship dragging anchor, or the surging of the vessel causing lines to become fouled. Divers working in deep water will have their time on the bottom shortened and will have to undergo extended decompression periods. This will necessitate a large manning requirement in order to rotate divers safely so as to keep the operation going and take advantage of good weather.

A Salvage Officer can begin to appreciate the involvement of personnel and time in performing an underwater salvage job by reviewing the operations discussed in the Appendices. Apply these experiences to a different salvage problem, such as one in 350 feet of water with a hard clay and rock bottom. How long would a diver be able to work with a lance in washing a tunnel? What are the risks involved when divers enter compartments to seal them? What is available to commence such a salvage job under these conditions? The purpose of this submarine salvage manual is to provide answers to some of these questions and to help the Salvage Officer in estimating his job and planning for the successful recovery of a submarine.

TABLE 1-1

ACCIDENTAL SUBMARINE SINKINGS SINCE 1904

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
March 18, 1904	U.K.	A-1	42	11	yes	Collision; rammed at periscope depth by the SS BERWICK CASTLE off Nab Lightship, Spithead, England.
June 20, 1904	Russia	DELFIN	*	26	yes	Flooded via open hatch while trimming on the surface off Kronstadt, Russia, by wash from passing steamer.
1905	France	ANGUILLE	*	none	yes	Gasoline explosion.
June 8, 1905	U.K.	A-8	180	14	yes	Flooded via open hatch while making high speed on surface; off Plymouth, England.
July 6, 1905	France	FARFADET	100	all	yes	Flooded via open hatch while diving off Bizerte, Tunisia.
Oct. 16, 1905	U.K.	A-4	*	*	no	Rammed off Plymouth, England.
Aug. 13, 1906	France	ESTURGEON	*	none	yes	Sunk at dock at Saigon.
Oct. 16, 1906	France	LUTIN	110	13	yes	Flooded via leaky hull plates, after end; lost off Bizerte, Tunisia.
Jan. 11, 1907	France	ALGERIEN	40	none	yes	Sunk during absence of crew because of carelessness in mooring.
April 26, 1909	Italy	FOCA	*	13	yes	Flooded after internal explosion.
June 12, 1909	Russia	KAMBALA	*	20	no	Rammed by battleship RESTISLAV while running on surface; cut in half and sunk.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
July 14, 1909	U.K.	C-11	*	13	no	Sunk in collision with SS EDDISTONE off Dover, England.
April 15, 1910	Japan	No. 6	*	14	no	Flooded via open ventilation valve during deep dive.
May 26, 1910	France	PLUVIOSE	*	26	*	Collided with mail steamer PAS DE CALAIS in English Channel.
June 1, 1910	Russia	FOREL	*	*	yes	Sunk while being towed.
Jan. 17, 1911	Germany	U-3	30	3	yes	Flooded while at mooring in Kiel docks. Men escaped via torpedo tubes. Lifted by crane.
Feb. 2, 1912	U.K.	A-3	66	14	yes	Rammed by gun boat HAZARD off Isle of Wight while running submerged.
June 8, 1912	France	VENDEMI-AIRE	350	24	no	Broke surface ahead of battleship ST. LOUIS during maneuvers off Cape de la Hague, France.
Oct. 4, 1912	U.K.	B-2	*	15	no	While running on surface at night off Dover; was rammed and sunk by liner AMERIKA; probably cut in two.
1913	Russia	MINOGA	*	none	yes	123-ton. Sunk near Libau in the Baltic Sea. Cause unknown-pulled to surface 12 hours after sinking.
June 8, 1913	U.K.	E-5	*	3	*	Flooded following internal explosion; sunk.
Dec. 10, 1913	U.K.	C-14	*	none	yes	Running on surface in Squadron. Rammed by lighter and sunk.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
1914	Nether-lands	O-5	*	1	yes	Sunk at Scheldt Quay, Nether-lands
Jan.16, 1914	U.K.	A-7	150	11	no	Failed to come to the surface after submerged run in Whitesand Bay off Plymouth, England.
July 8, 1914	France	CALYPSO	500	3	no	Collision with submarine CIRCE while cruising on the surface; due to jammed rudder.
Sept.14, 1914	Australia	AE-1	*	all	no	Failed to return from training dive.
March 25, 1915	U.S.	F-4	306	22	yes	Flooded; failure of hull plates during dive off Honolulu.
Aug.8, 1916	U.K.	E-4	66	all	no	Collision with the E-41 off Harwich, England.
Aug.8, 1916	U.K.	E-41	60	none	yes	Collision with the E-4.
Oct.10, 1916	Denmark	DYKKEREN	28	1	yes	Sunk off Copenhagen after collision with a Norwegian merchantman abaft conning tower.
Jan.29, 1917	U.K.	K-13	55	49	yes-and recommissioned as K-22	Flooded; boiler room ventilators open during test dive in the Gareloch, Scotland.
March 19, 1917	Germany	UB-25	*	16	yes	Rammed and sunk with DDV-26.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
Sept.14, 1917	U.S.	D-2	30	none	yes	Flooded at dockside via "slow leaks" into machinery compartment; New London, Conn.
Sept.17, 1917	Germany	UC-45	*	*	yes- and re-commissioned	Foundered in North Sea as result of material failure.
Nov.18, 1917	U.K.	K-1	*	none	*	Sank in North Sea after collision with H.M. sub K-4.
Dec.6, 1917	Germany	UC-69	*	11	*	Sank in English Channel after collision with U-96.
Dec.7, 1917	Germany	UB-84	*	19	yes- and re-commissioned as training boat	Sunk in Baltic Sea following collision.
Dec.17, 1917	U.S.	F-1	600	19	no	Collision; port side abaft the main hatch; off Point Loma,Calif. Collided with F-3.
1917	U.K.	H-5	*	all	no	Collision; rammed by British merchant vessel, mistaken for a German submarine.
Jan.31, 1918	U.K.	K-17	*	42	no	Sunk by collision with British cruiser FEARLESS off Firth of Forth, Scotland.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
Jan.31, 1918	U.K.	K-4	*	50	no	Sunk by collision with British SS K-6 off Firth of Forth, Scotland.
Feb.18, 1918	Russia	IGOR	*	*	*	Foundered in the ice off Revel, Estonia.
March 15, 1918	Germany	UB-106	*	35	yes- and re-commis-sioned	Sunk in Baltic Sea through mate-rial casualty.
April 29, 1918	France	PRAIRIAL	*	*	*	Sunk by collision with merchant-man off Le Havre, France.
Aug.2, 1918	France	FLOREAL	*	*	*	Sunk by collision off Saloniki, Greece.
Sept.5, 1918	Germany	UC-91	*	*	yes- and re-commis-sioned	Sunk by collision with German steamer ALEXANDER WOERMANN.
Oct.21, 1918	Germany	UB-89	*	7	yes- surren-dered after armistice	Sunk by collision with German cruiser FRANKFURT.
July 30, 1919	U.S.	G-2	80	3	yes	Flooded via leaky hatch cover in heavy seas; Long Island Sound. Salved by blowing apart, 1962.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
March 12, 1920	U.S.	H-1	50	4	no	Grounded during storm near Point Redondo, Magdalena Bay, Columbia. Later sank during salvage operations.
Sept.1, 1920	U.S.	S-5	194	none	no	During dive, flooded via open main induction; off the Delaware Capes. Stern was raised and crew escaped through hole cut in stern. Later attempts to salve were a failure.
Jan.20, 1921	U.K.	K-5	*	57	no	Cause unknown; 120 miles S.W. of Scilly Islands while practicing an attack on the Atlantic Fleet.
Sept.26, 1921	U.S.	R-6	32	2	yes	Flooded via tube; failure of interlocking mach.; alongside her tender, CAMDEN, San Pedro Harbor, Calif. Raised in 17 days.
Oct. 1921	Nether-lands	O-8	*	none	yes	After section filled with water and sank during her fitting-out period in the basin at Den Helder, Netherlands.
Dec.7, 1921	U.S.	S-48	67	none	yes	Flooded via manhole cover from MBT #5, during trials, Long Island Sound off Bridgeport, Conn.; escape was made via torpedo tube.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
March 23, 1922	U.K.	H-42	3000	26	no	Collision with destroyer; was rammed and sunk after it broke surface ahead of VERSATILE off Gibraltar.
July 17, 1923	U.S.	S-38	102	none	yes	In Anchorage Bay, Alaska; sank due to accidental flooding of the motor room; S-38 settled by the stern until water came up to conn. tower plat. aft; further sinking prevented by air pressure. Towed into shoal water and pumped out.
Aug.21, 1923	Japan	RO-31	*	all	yes	Flooded; premature opening of hatch before securely surfaced off Kariga, Hyogoken.
Oct.29, 1923	U.S.	O-5	42	3	yes	Collided with United Fruit steamer ABANGARES; approx. amidships; Limon Bay near entrance to Panama Canal Zone.
Jan.10, 1924	U.K.	L-24	180	41	no	During mimic attack on the Atlantic Fleet battleships, surfaced almost under bow of the battleship, RESOLUTION, and was rammed.
March 19, 1924	Japan	RO-25 (ex-#43)	156	all	no	Collision with cruiser TATSUTA off Sasebo Harbor, Japan.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
Aug.26, 1925	Italy	SEBASTIANO VENIERO	300	all	no	Collision off Cape Passero, Sicily, with SS CAPEA while running submerged.
Sept.25, 1925	U.S.	S-51	132	33	yes	Collision with SS CITY OF ROME off Block Island. Hit fwd. of the conn. tower, port side.
Oct.29, 1925	Japan	RO-52 (ex-#26)	48	none	yes	Flooded via tube during repairs, Kure Harbor, Japan, alongside cruiser YAHAGI.
Nov.12, 1925	U.K.	M-1	*	all	no	Collision with Swedish steamer, VIDAR, while running submerged in the North Atlantic.
Aug.9, 1926	U.K.	H-29	32	6	yes	Flooded at dockside while trimming on the surface with open hatches.
Dec.17, 1927	U.S.	S-4	102	all	yes	Collision with USCG destroyer PAULDING just fwd, amidships, while off Provincetown, Mass.
Aug.6, 1928	Italy	F-14	*	31	yes	Collision off Pela in Adriatic Sea with Italian destroyer MISSORI.
Oct.3, 1928	France	ONDINE	*	43	no	Collision off Vigo, Spain, with a Greek steamer.
July 8, 1929	U.K.	H-47	*	20	no	Collision with the British submarine L-12 in St. George's Channel off Pembroke, Wales. Two men on L-12 lost.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
May 26, 1931	Russia	B-9 (ex-RABOCHY)	*	"heavy"	*	Cause unknown; lost during maneuvers in the Gulf of Finland.
June 9, 1931	U.K.	POSEIDIN	130	21	no	Collision with steamer TUTA off Wei Har Wei, China.
Oct.24, 1931	Russia	L-55 (ex-British L-55)	*	all (50)	no	Sunk by unknown causes in the Gulf of Finland.
Jan.26, 1932	U.K.	M-2	106	all	no	Flooded during plane launching operations off Portland Bill, England.
Feb.25, 1932	U.K.	H-42	*	all	no	Sunk by unknown causes off Gibraltar.
July 7, 1932	France	PROMETHEE	150	63	no	Flooded via failure of hydraulic MBT vents off Cherbourg, France.
July 25, 1935	Russia	B-3	*	55	yes	Collision with battleship MARAT while surfacing in the Baltic Sea.
Nov.20, 1936	Germany	U-18	*	8	yes- and re-commis-sioned	Sunk by collision with German torpedo-retriever T-156 off Luebeck, Germany.
Dec.12, 1936	Spain	unidenti-fied	*	45	no	Sunk by internal explosion off Malaga, Spain.
Feb.2, 1939	Japan	I-63	*	all	no	Collision; lost in Bungo Channel.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
May 23, 1939	U.S.	SQUALUS	240	26	yes	Flooded, mechanical failure of main engine induction valve during test dive off Portsmouth, N.H.
June 1, 1939	U.K.	THETIS	120	99	yes	Flooded via torpedo tube off Mersey, Liverpool Bay.
June 16, 1939	France	PHENIX	390	all	no	Cause unknown; lost off Point Cam Ranh Bay, South Vietnam.
July 24, 1939	Russia	SHCH-424	*	*	no	Sunk by collision with a fishing trawler in Kola Inlet, Barents Sea.
Jan.30, 1940	Germany	U-15	*	*	*	Sunk by collision with German destroyer IL TIS off Helgoland, North Sea.
March 6, 1940	Nether-lands	O-11	30	3	yes	Collision; rammed by Naval tug while on the surface off Helder Navy Yard, Netherlands.
April 29, 1940	U.K.	UNITY	*	4	*	Sunk by collision with steamer ATLE JARL off South English coast.
Aug.29, 1940	Japan	I-67	*	*	*	Sunk during maneuvers in Japanese waters.
Nov. 1940	Russia	D-1	*	*	no	Sunk by diving accident in Motovsky Bay, Arctic Coast.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
June 20, 1941	U.S.	O-9	440	all (33)	no	Flooded; crushed hull while exceeding test depth of 212 ft. off Isle of Shoals, New England Coast.
July 19, 1941	U.K.	UMPIRE	65	15	no	Collision; rammed forward by A/S trawler P. HENDRICKS.
Oct. 1941	Germany	U-579	*	*	yes-recommissioned	Sunk by collision in Baltic Sea.
Oct.3, 1941	Japan	I-61	*	all	yes	Cause unknown; lost off Kyushu, Japan.
Nov.11, 1941	Germany	U-580	*	12	*	Sunk by collision off Memel, E. Prussia.
Nov.15, 1941	Germany	U-583	*	45	*	Sunk by collision in Danzig Bay, Baltic Sea.
Jan.24, 1942	U.S.	S-26	300	46	no	Collision with PC 460 while on surface; stbd., amidships; 14 miles off Balboa, Canal Zone.
May 2, 1942	Poland	JASTRZAB (ex-Brit-P551) (ex-US S-25)	*	*	*	Sunk by collision with British Battleship KING GEORGE V in the Norwegian Sea.
May 1942	Russia	SHCH-212	*	*	no	Lost near Sevastopol on the Black Sea due to explosion of gasoline fumes.
June 21, 1942	U.K.	P-514	*	all	no	Cause unknown; reported as rammed and sunk by HMCS GEORGIAN in West Atlantic Ocean.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
July 14, 1942	Turkey	ATILAY	*	*	*	Lost by accident while on trials off Kanakkale, Turkey.
Aug.6, 1942	Germany	U-612	*	*	yes-recommissioned as a training boat	Sunk off Warnemuende, Baltic Sea Coast by material casualty.
Sept.2, 1942	Germany	U-222	*	42	*	Sunk by collision off Pillau, East Prussia.
Sept.4, 1942	Sweden	SJOEBORREN	*	*	yes-recommissioned	Lost by collision in the Baltic Sea.
Sept.27, 1942	Japan	I-33	*	*	yes-recommissioned	Accidentally foundered at TRUK Island.
Nov.4, 1942	U.K.	X-3	114	3	yes	Flooded via leaky sea valve in Loch Striven.
Nov.12, 1942	Germany	U-272	*	28	*	Lost by collision off Hela Peninsula, Baltic Sea.
Feb.24, 1943	Germany	U-649	*	35	*	Lost by collision in the Baltic Sea.
Feb.24, 1943	U.K.	VANDAL	*	*	*	Sank in the Firth of Forth due to diving failure.
March 19 1943	Germany	U-5	*	21	*	Lost in Danzig Bay due to diving failure

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
May 30, 1943	U.K.	UNTAMED	160	all	yes-recommissioned as VITALITY	Flooded off Campbeltown, Scotland.
June 12, 1943	U.S.	R-12	600	42	no	Flooded via forward torpedo tube during training cruise south of Florida.
1943	Norway	WELLMAN X	186	none	no	Cause - accident.
July 14, 1943	Japan	I-179	*	*	*	Accidental sinking, Inland Sea.
Aug.5, 1943	Germany	U-34	*	4	*	Sunk by collision off Memel, East Prussia.
Aug.12, 1943	Sweden	ILLERN	*	*	yes	Sunk by collision with a steamer in the Baltic Sea.
Aug.20, 1943	Germany	U-670	*	21	*	Sunk by collision with target ship BOLKOBURG in Bay of Danzig, Baltic Sea.
Sept. 1943	Russia	M-60	*	*	no	Failed to surface after diving in the Black Sea.
Sept.20, 1943	Germany	U-346	*	37	*	Accidental sinking in the Baltic Sea.
Nov.18, 1943	Germany	U-718 q	*	43	*	Sunk by collision with U-476 off Bornholm, Is., Baltic Sea.
Nov.20, 1943	Germany	U-768	*	*	*	Lost by collision, Baltic Sea.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Dept (Ft)	Men Lost	Salved	Geographical Location and Cause
Feb.14, 1944	Germany	U-738	*	9	*	Lost by collision with steamer off Gdynia, Baltic Sea.
Feb.18, 1944	Germany	U-7	*	26	*	Diving failure in Danzig Bay, Baltic Sea.
1944	Germany	U-1013	*	25	*	Lost by collision with U-286 east of Ruegen Is., Baltic Sea.
April 8, 1944	Germany	U-2	*	27	yes	Lost by collision with fishing trawler H. FROESE off Pillau, Baltic Sea.
May 14, 1944	Germany	U-1234	*	13	yes-recommissioned	Lost by collision with a tug off Gdynia, Baltic Sea.
May 19, 1944	Germany	U-1015	*	36	*	Sunk by collision with U-1014 in Danzig Bay, Baltic Sea.
June 13, 1944	Japan	I-33	*	*	*	Lost in Inland Sea by material casualty.
July 4, 1944	U.S.	S-28	8400	50	no	Cause unknown; material casualty; lost off Hawaii.
July 22, 1944	Germany	U-1166	*	*	raised-scrapped	Sunk in Eckern Fjord, Baltic Sea, by torpedo explosion.
July 27, 1944	Russia	V-1 (ex Brit SUNFISH)	*	*	no	Sunk by mistake by British aircraft in the North Sea.
Sept.21, 1944	Russia	SHCH-402	*	*	no	Sunk by mistake by Soviet aircraft near Fish Harbor, Norwegian Coast.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
Sept. 1944	Germany	U-703	*	54	*	Foundered east of Greenland while attempting recovery of a weather buoy.
Oct.10, 1944	Germany	U-2331	*	15	*	Sunk off Hela Peninsula, Baltic Sea, due to material casualty.
Nov.28, 1944	Germany	U-80	*	*	*	Material casualty, Baltic Sea.
Dec.12, 1944	Germany	U-416	*	36	*	Rammed and sunk by German mine-sweeper while approaching Pillau, E. Prussia.
Dec.30, 1944	Germany	U-382	*	*	*	Sunk by collision in Danzig Bay, Baltic Sea.
Feb.18, 1945	Germany	U-2344	*	7	*	Sunk by collision off Heligendamm, Baltic Coast.
March 6, 1945	U.K.	XE-11	204	2	no	Collision while running submerged; Loch Striven.
May 12, 1946	France	U-2326 (ex German)	*	*	*	Lost by material casualty off Toulon, France.
June 1946	Spain	C-4	*	*	*	Sunk by collision with the Spanish Destroyer LEPANTO in exercises off the Bolearic, Is.
Nov.21, 1947	U.K.	P-511	*	all	yes-raised-scrapped	Cause unknown; reported as lost as the result of "perils of the sea."

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
Aug.26, 1949	U.S.	COCHINO	840	one civilian technician	no	Flooded following hydrogen explosions; in the Barents Sea, 100 miles north of Hammerfest, Norway. USS TUSK assisted in rescue and lost six of her crew.
Jan.12, 1950	U.K.	TRUCULENT	66	61	yes	Collision with Swedish tanker DIVINA; 55 miles east of London, Thames Estuary.
April 17, 1951	U.K.	AFFRAY	198	75	no	Flooded due to failure of snorkel mast weldment; English Channel.
Sept.24, 1952	France	LA SIBYLLE	3000	70	no	Flooded in unknown manner, near Toulon, France.
April 4, 1953	Turkey	DUMLUPINAR (ex-USS BLOWER-SS 325)	228	all	no	Collided with Swedish NABOLAND, struck near the bow; in Dardanelles.
June 16, 1955	U.K.	SIDON	36	13	yes	Flooded, internal casualty in Portland Harbor, England.
May 30, 1958	U.S.	STICKLE-BACK	9000	none	no	Collision during maneuvers with destroyer, 19 miles S.W. of Pearl Harbor.
1959	Chile	O'BRIEN	30	none	no	Slow flooding overnight while moored; near Naval Base, Talcahuano, Chile.

* Unknown

TABLE 1-1 (Cont)

Date	Country	Submarine	Depth (Ft)	Men Lost	Salved	Geographical Location and Cause
April 10, 1963	U.S.	THRESHER	8400	129	no	Cause unknown; off New England Coast.
Oct. 1963	Russia	PUCHINA	*	*	yes	Sunk in collision with merchant-ship Kola Gulf, Barents Sea.
Sept.15, 1966	West Germany	HAI	145	19	yes	Flooded during North Sea Gale.
Jan. 26 1968	Israel	DAKAR	*	69	no	East Mediterranean
Jan. 27 1968	France	MINERVE	*	52	no	Western Mediterranean
May 27 1968	U.S.	SCORPION	12000	99	no	Atlantic, South-West of the Azores
May 15 1969	U.S.	GUITARRO	35	0	yes	Mare Island Naval Shipyard, Vallejo, California; flooded.
March 2 1970	France	EURYDICE	*	45	no	Mediterranean