MARITIME NEW ZEALAND

Accident report

Blue Dolphin

Collision resulting in one fatality and two persons missing, presumed drowned

21 October 2009

Maritime New Zealand

Maritime New Zealand (MNZ) is a Crown Entity appointed under section 429 of the Maritime Transport Act 1994, with the responsibility to promote maritime safety, security and the protection of the marine environment.

Section 431 of the Maritime Transport Act sets out MNZ's functions. One of those functions is to investigate and review maritime transport accidents and incidents.

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Glossary of terms

ECAN	Environment Canterbury
EPIRB	Emergency Positioning Indicating Radio Beacon
GMDSS	Global Maritime Distress Safety System
GPS	Global Positioning System
LINZ	Land Information New Zealand
MNZ	Maritime New Zealand
NPBSF	National Pleasure Boat Safety Forum
NRBSS	National Recreational Boating Safety Strategy
PFD	Personal Flotation Device
PLB	Personal Locator Beacon
RCCNZ	Rescue Coordination Centre of New Zealand
RPM	Revolutions per minute
SAR	Search and rescue
SOLAS	Safety of Life at Sea
VHF	Very High Frequency

Summary

1. At about 7.30am on Wednesday, 21 October 2009, the recreational vessel ***Blue Dolphin*** was launched at Lake Tekapo with the intention of fishing for trout in the lake. There were three men on board: the skipper and his two passengers. At 10.10pm, Police were alerted to the vessel being overdue and a search and rescue operation commenced. ***Blue Dolphin*** was located at 12.18am, resting semi-submerged on a shingle bar. One of the passengers was found deceased at 6.50am the following morning. The skipper and the remaining passenger are still missing, presumed dead.

2. ***Blue Dolphin*** was recovered from the shingle bar on 22 October 2009. An examination of the vessel by Maritime New Zealand (MNZ) investigators determined that ***Blue Dolphin*** had collided with a solid object while underway.

3. As a result of the investigation into this matter, MNZ has made several recommendations regarding information that should be highlighted within the recreational boating community.

Figure 1 ***Blue Dolphin*** post-recovery

Factual information

4. The information within this report comes from a variety of sources, including witness statements, government and voluntary organisations, and the New Zealand Police.

5. At about 6.15am on 21 October 2009, the skipper and his two passengers left Timaru with the intention of heading to Lake Tekapo and fishing at the mouth of the McCauley River. Lake Tekapo can be a busy lake, but on this occasion no-one saw the men launch ***Blue Dolphin*** and there were no witnesses to the activities on the lake that day.

6. At 10.10pm, Police communications received a call from the skipper's wife, concerned that the three men had not returned home. A check of the boat ramp found that the vehicle in which they were travelling and ***Blue Dolphin's*** trailer were there and unattended.

7. A search and rescue operation involving the Rescue Coordination Centre New Zealand (RCCNZ), New Zealand Police, New Zealand Army and volunteers was launched shortly thereafter on 21 October 2009.

8. At 12.18am on 22 October 2009, the aerial search located ***Blue Dolphin*** unoccupied and resting firmly in waist-deep water on a shingle bar at the mouth of the Cass River. ***Blue Dolphin*** was partially submerged and there was no obvious indication of what had occurred.

9. At 6.50am, the body of one of the passengers was recovered from Motuariki Island, approximately 2.7 nautical miles (5km) from where ***Blue Dolphin*** ran aground. He was not wearing a lifejacket or any other personal flotation device (PFD) or buoyancy aid, although he was wearing a neoprene back support which provided some buoyancy and resulted in the discovery of his body.

10. A subsequent post-mortem examination concluded the passenger had suffered injuries consistent with a high-impact collision and drowned.

11. The search and rescue operation continued throughout the day. Searchers combing the shore located numerous items from ***Blue Dolphin*** along the shoreline. The aerial phase of the search and rescue operation was called off later on 22 October 2009. Searchers continued to comb the shoreline for several days after the accident, but the skipper and remaining passenger were not located and are presumed dead.

12. Police recovered ***Blue Dolphin*** from the mouth of the Cass River on 22 October 2009 and an examination of the vessel followed.

Comment and analysis

The vessel

13. ***Blue Dolphin*** is a 15-foot fibreglass Plylite Fisherman, manufactured in the early 1970s by Plylite. Plylite was founded in Paraparaumu, New Zealand, and was the first company in New Zealand to build fibreglass-over-ply vessels. The company was sold in 1974 and shifted to Nelson. At the peak of its productivity, Plylite produced an average of 100 vessels a month. It was around this time, in the early to mid-1970s, that the Fisherman model was produced.

14. ***Blue Dolphin*** was located at the mouth of the Cass River. She had run aground and was sitting firmly on a shingle bank in waist-deep water. The cuddy cabin can be seen protruding from the water in the image below. This photograph was taken when the weather had calmed and the waves on the lake, which had filled ***Blue Dolphin***, had receded.

Figure 2 ***Blue Dolphin*** at the mouth of the Cass River

15. Police recovered ***Blue Dolphin*** at about 4.00pm on 22 October 2009. An examination of the vessel was conducted by MNZ investigators shortly thereafter. The findings of the examination are as follows:

16. ***Blue Dolphin*** had not undergone any major modifications since manufacture and was in average condition for her age. Overall, the vessel appeared to have been reasonably maintained and serviced.

17. ***Blue Dolphin*** was generally used as a recreational fishing vessel. When recovered, the vessel was equipped for a day's fishing on the lake. This included packed lunches, thermos flasks, trout fishing rods, a landing net, tackle and other assorted fishing gear.

18. Although transported on an appropriate trailer, some wear was evident on the keel, and the gel coat in this area had worn through. The fibreglass in this area was also beginning to wear thin and several small areas had been patched.

19. Several areas of impact damage were evident on the worn area of fibreglass. Two of these areas were leaking water held in the void space of the hull. They included a jagged crack of approximately 115mm, which appeared recent and is indicative of the vessel having struck a solid object.

Figure 3 General wear on the keel

Figure 4 The 115mm jagged crack in the keel, midships

Figure 5 An expanded view of Figure 4, showing the 115mm jagged crack in the keel, midships

20. A smaller area of recent impact damage was situated slightly forward of the larger crack shown in Figure 5. This damage is consistent with the vessel striking a solid object.

Figure 6 Impact damage on the keel

21. In front of these two areas of damage was an area approximately 190mm long of eggshell-like cracking. The force involved in causing this damage was sufficient to smash away the gel coat altogether, and water held in the void space was dripping through.

Figure 7 Impact damage on the keel

22. A stress fracture was located on the exterior port side of the hull. This damage corresponded with a similar-sized stress fracture in the interior of the vessel, at a junction with the seat combing.

Figure 8 Exterior stress fracture

Figure 9 Corresponding interior damage

23. Two other similar fractures, measuring 190mm and 210mm, were present in the floor on the starboard side, beneath the seating squabs.

Figure 10 Fractures in the fibreglass floor beneath a seating squab

24. All of these areas of damage were recent, and are considered consistent with the vessel having struck a solid object.

25. Both bungs of the vessel were secured and watertight. However, investigators removed 155 litres of water from the void space beneath the floor. It is most likely this water came from waves entering the vessel as it sat on the shingle bar. The water would have easily found its way into the void space through an area of older damage found on the fuel tank combing (refer to Figure 11). When recovered, the vessel floated with this volume of water in the void space. This is not considered causative in the accident, and the damage simply explains how the water came to be there.

Figure 11 Area of old damage on the fuel tank combing

26. ***Blue Dolphin*** was fitted with a 90 horsepower Johnson outboard engine, model J6RCRM, which was controlled remotely. The manual for this was located in the bow of the vessel and showed that the engine was sold new in 1996. It was then recently sold, second hand, to the skipper of ***Blue Dolphin***.

27. Inquiries located the marine service supplier, who had only recently fitted the second-hand engine to ***Blue Dolphin***. This was confirmed by the skipper's family, who believed the engine had been used for approximately four hours on the vessel. The supplier stated that prior to selling the engine, he had touched up the paintwork, the skeg was straight and the propeller was in good order. It follows that the damage shown in Figure 12 was new, and a family member familiar with the vessel was able to confirm that it was.

Figure 12 The stern leg

28. Figure 12 also shows stone chips in the paint on the stern leg. This damage extended to beneath the anti-cavitation plate and trim tab. It is indicative of the propeller churning up stones on the shingle bar. MNZ investigators were unable to determine exactly how long the vessel may have been churning up stones on the shingle bar, although the extent of the damage indicates it was not something that occurred immediately.

29. Two stones were found wedged firmly in the water intakes (one on each side). These were held too firmly to have been sucked in, and show the vessel was driven into the shingle bar with sufficient force to wedge the stones.

30. The skeg of the engine was bent approximately 10 degrees to starboard. This type of skeg is manufactured from alloy and is known to snap off or chip if run onto such things as rocks, stones or concrete boat ramps. However, the skeg was relatively undamaged, suggesting that it was bent by striking something other than rocks, the shingle bar or concrete.

31. The marine service supplier stated that the skeg was straight and undamaged at the time of fitting it to ***Blue Dolphin.*** A family member viewed the bent skeg and confirmed the skeg had been straight prior to the day of this accident. A significant amount of force would be required to bend the skeg, and this type of damage most likely resulted from striking a solid object such as a log or tree stump.

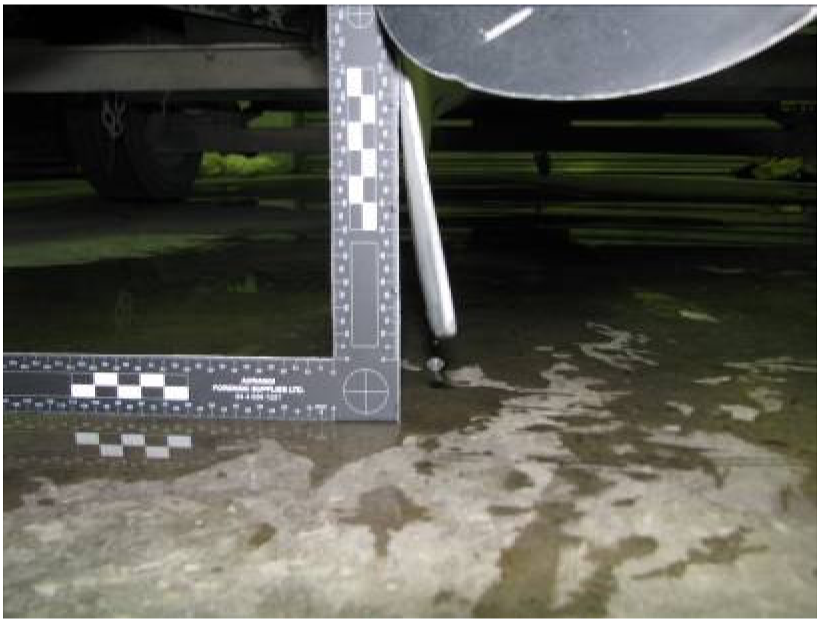

Figure 13 The bent skeg

32. When later tested, the engine turned over freely. There was no evidence of the engine having heat-seized through a lack of water or stopped as a result of water being sucked into the engine. One of the 20 litre fuel tanks was approximately half full and the other held a small amount of petrol. However, a water/fuel mix was found in the carburettor, and silt was present in the pan of the engine housing. The introduction of water to the fuel system is believed to have caused the engine to stall. The silt found in the pan of the engine housing most likely came from the propeller churning up the shingle bar, silting the water that was being washed into the engine.

33. The remote functions of the engine operated correctly. The key was found turned on, the engine was in the forward gear and the throttle was set at about 95%. The Johnson *Operation and Maintenance Manual* described that, when set in this position, the engine would produce 4500–5500 rpm, indicating the vessel was well underway at the time it was driven onto the shingle bar.

34. The emergency stop switch had not been activated and the clip and lanyard were still attached to the remotes (refer to Figure 14). This type of switch is common on outboard engines. The lanyard is designed to be attached to the person operating the engine. In the event that this person is thrown or falls from the vessel, the switch will immediately stop the engine and the vessel will not run away.

35. The manual advises operators on the appropriate use of the emergency stop switch, stating:

> *Connect the clip to the emergency stop switch. Snap the lanyard to a secure place on the operator's clothing or life vest – not where it might tear away instead of activating the stop switch. Disconnecting the clip and lanyard will stop the engine and prevent the boat from becoming a runaway if the driver moves beyond the range of the lanyard.*
>
> *Safety Warning: Your emergency stop switch can be effective only when in good working condition.*

Figure 14 Throttle control, emergency stop switch and lanyard

36. The engine was equipped with a power tilt and trim function, which allowed the skipper to raise or lower the engine while underway. This function was performed by operating the trim tilt button situated on the throttle. When later examined, the trim tilt function was found to operate correctly with the full range of movement.

37. 'Trim' is the term used to define an outboard engine's angle in relation to the hull. The ideal trim angle is one that causes the vessel to ride level, with most of the hull on the surface, instead of ploughing through the water. If the engine is trimmed out too far, the bow will ride high out of the water and the stern will be driven lower into the water. With too little trim, the bow rides too low.

38. It is also common for recreational boaters to trim an engine where there is a chance of the propeller touching the bottom, such as on a river mouth where shingle bars are common and the water may be shallow. When ***Blue Dolphin*** was recovered, the engine was found to be fully down, which is inconsistent with boating in shallow water such as at the mouth of the Cass River where ***Blue Dolphin*** was found.

39. A wedge plate had been fitted to adjust the trim of the engine. This plate was placed between the engine mount and the transom, and secured with two bolts through all three components (refer to Figures 15 and 16). The nuts on the bolts were loose to the extent that they could not be measured by a torque wrench.

40. The nuts are self-locking, so any normal engine vibration is not likely to have loosened them. The nuts had not moved on their threads, so it is believed that the engine had received a substantial knock or struck a solid object with some force, so that the wedge plate was loosened.

41. A length of edging positioned on the top edge of the transom had been forced upwards by the wedge plate, and markings on the transom showed how the wedge plate had shifted from its original position. This probably occurred through the application of substantial force.

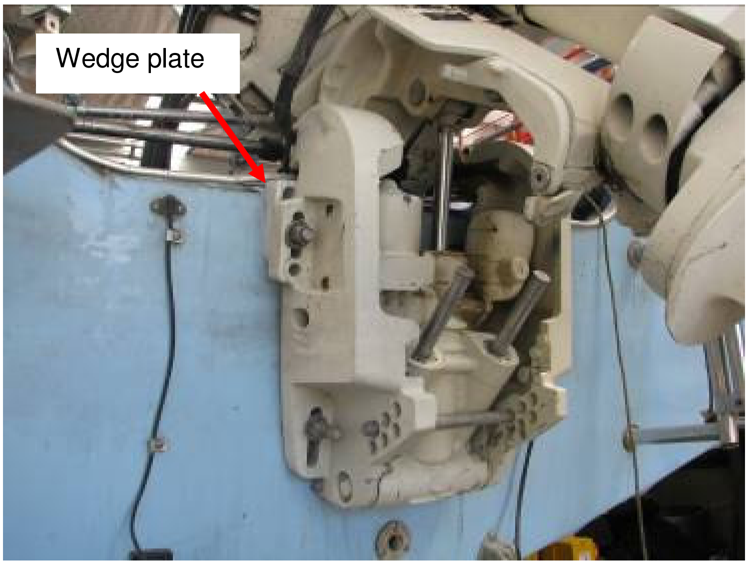

Figure 15 Engine mounting and transom

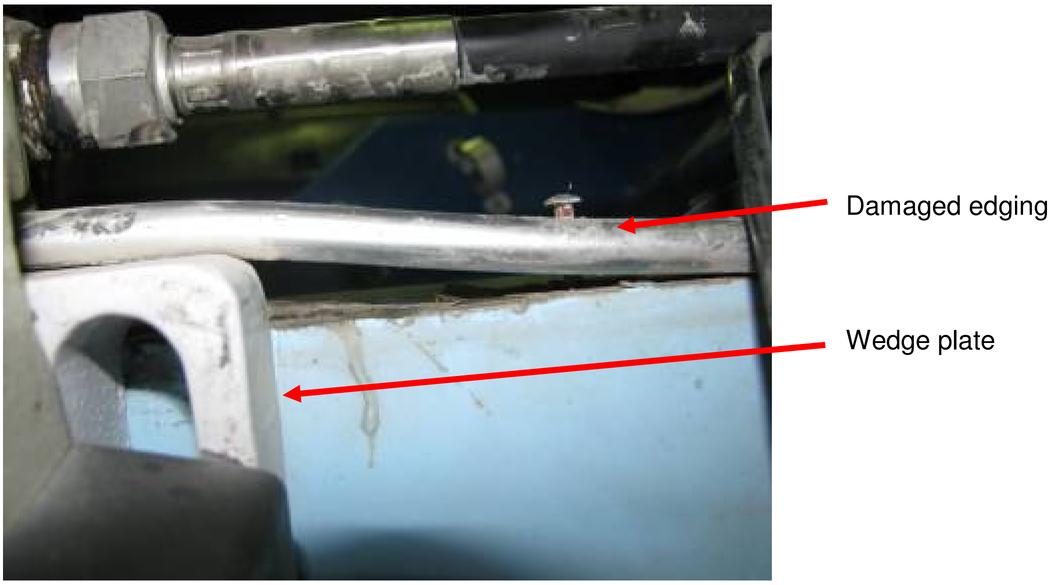

Figure 16 Edging on transom, forced upwards by the wedge plate

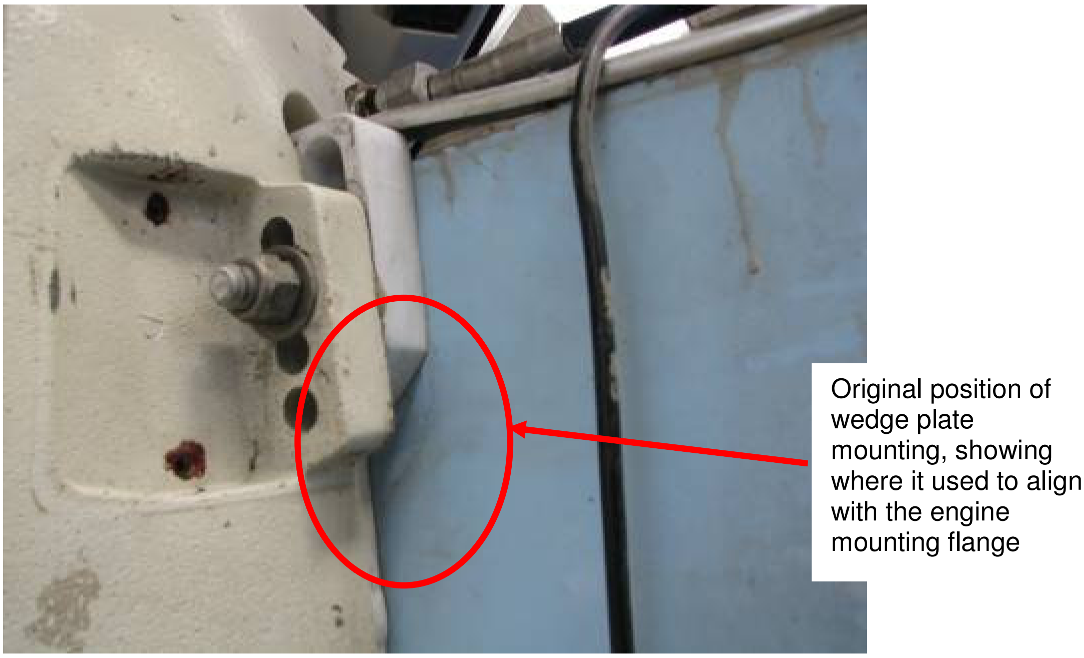

Figure 17 Closer view of the engine mounting

42. Several items were left in ***Blue Dolphin***, which suggests the occupants did not abandon the vessel in a planned way. Gear bags, a wallet, PFDs, buoyancy aids, food, warm clothing and hot thermos flasks, which were left behind, all indicate that the occupants exited the vessel quickly and without preparing themselves for time in the water or being cold on the shore.

43. The occupants were carrying cellphones as their only means of communication, but no calls for help or assistance were made.

44. The significant factors discovered during the vessel examination are summarised below. All of these indicate ***Blue Dolphin*** struck a solid object at high speed, throwing the occupants from the vessel. It is unlikely that the exact position of where this occurred will ever be determined.

- Engine in gear and full throttle
- Stone damage to stern leg from vessel sitting, churning up stones
- Engine in low trim position
- Engine had received a substantial shunt
- Engine mounting nuts loose
- Wedge plate driven up into transom edging
- Safety equipment and gear left in vessel
- Damage to hull.

The fishing trip

45. The skipper and his passengers were all experienced in fishing for trout on Lake Tekapo, having fished this area on several previous occasions.

46. Before departing, they had informed family they intended to fish the McCauley River mouth at the northern end of the lake. Trout are commonly fished for in this area, which takes approximately 30 minutes to reach from the boat ramp in a vessel like ***Blue Dolphin***.

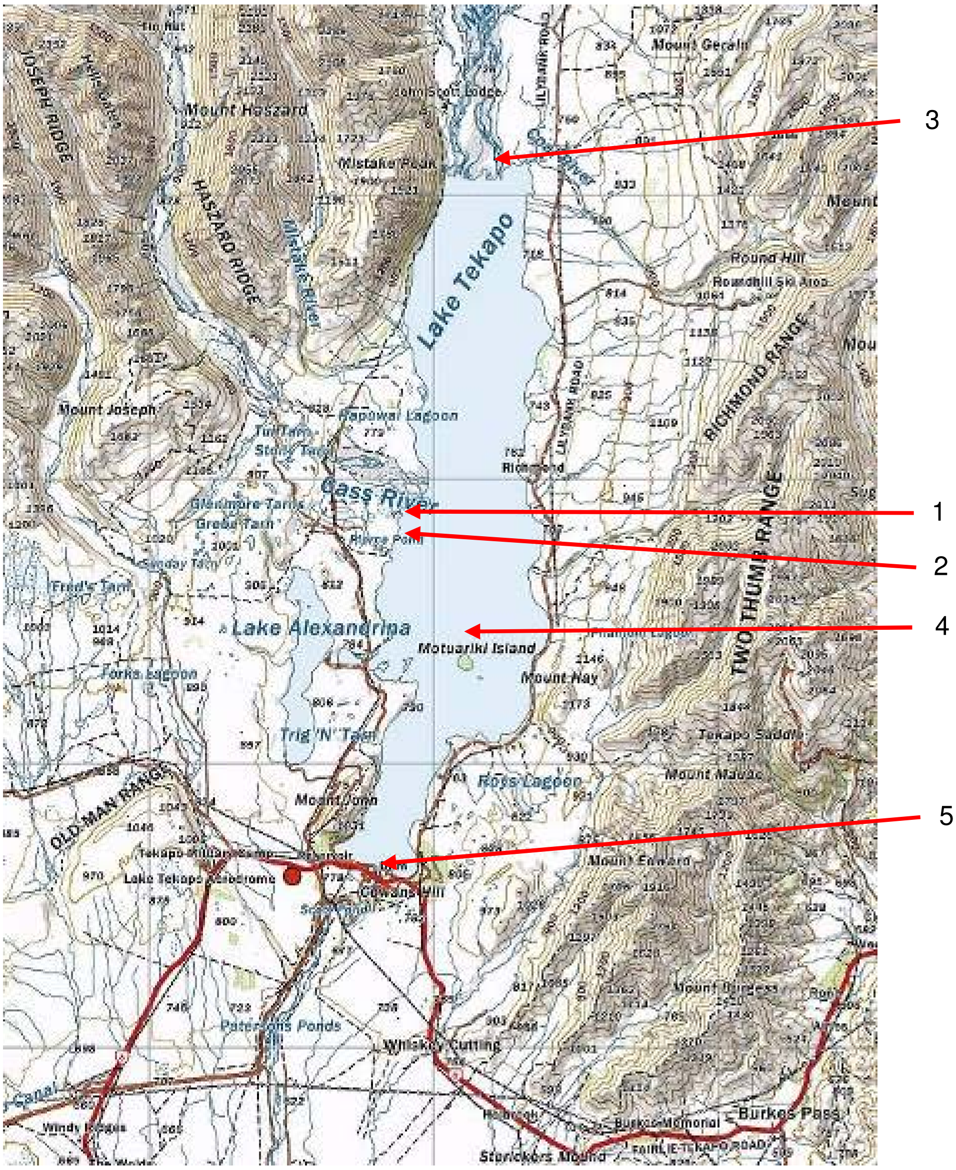

Figure 18 Map of Lake Tekapo

1. ***Blue Dolphin*** located
2. Items from ***Blue Dolphin*** recovered
3. McCauley river mouth
4. Deceased passenger located
5. Boat ramp.

47. ***Blue Dolphin*** would have left the boat ramp at 7.30–8.00am on 21 October 2009 and been fishing shortly afterwards. The exact timing of events or where the men fished is likely never to be accurately determined, and there are numerous scenarios of what they may have done. However, two fresh trout were found in the vessel, so some fishing had taken place. The passenger recovered from the water was wearing a wristwatch and this had stopped working at about 12.30pm, so it is most probable that the men were in the water by this time.

Environment

48. The skipper was known to always check the weather forecast before venturing out, and it is believed he had done so on this occasion.

49. The Southern Lakes forecast for 21 October 2009 was:

> *High cloud with rain developing about the headwaters. Scattered falls spreading further east from afternoon and rain easing in the evening. Wind at 1000m – north-west 40km/h. Wind at 2000m – north-west gale 65km/h, easing to 45km/h in the evening.*

50. Locals described the wind as having changed three times that day, and said the lake was 'rough', with large, 'choppy' waves produced by the wind increasing around midday. As a result of these wind changes, MNZ investigators were unable to determine a drift pattern to establish where ***Blue Dolphin*** was most likely to have collided with an object.

51. The increase in wind-chop coincides with the time it is estimated that the men found themselves in the water. It is not likely that they would have stayed out fishing in these conditions. Having caught two trout elsewhere on the lake, they were quite likely to be returning to the boat ramp or seeking shelter behind Motuariki Island.

52. Lake Tekapo is fed by the Godley Glacier, as well as by the Cass, Godley and McCauley rivers. These rivers are predominately fed by melting snow and ice, and the lake can be extremely cold, with surface water temperatures ranging from 6℃ to 16℃.

53. The search and rescue team recorded the water temperature on the day as 8.5℃. The lake level was recorded as 707m above sea level, which is normal for this time of year.

54. Locals spoke of trees or logs being found in the lake following periods of heavy rain or flooding. While the catchment area has no large forests, debris may wash down into the lake from the surrounding hill country, and this is something that could occur in almost any waterway of this nature. Note: When the lake level is lower than it was on this day, rocks that were previously at a safe depth can become navigational hazards.

55. Glacially fed lakes, such as Lake Tekapo, are often characterised by high sediment concentrations. This sediment includes a distinctive, fine-grained material known as rock flour or glacial flour, which gives the water an opaque or milky appearance.

56. Rescuers searching from the air described how they could see only a few centimetres into the water.

57. The effects of sun strike, glare, wind-ripple and wind-chop would further reduce the ability to identify potential hazards in the water.

58. Land Information New Zealand (LINZ) produces navigational charts that show, among other things, navigational hazards. However, those charts are primarily limited to the coastal environment, and Lake Tekapo remains uncharted at this time. Environment Canterbury (ECAN) is responsible for monitoring navigational hazards on Lake Tekapo and this is administered through its harbourmaster and navigational safety manager.

59. ECAN advised that large logs are uncommon in the lake, but there were already two large signs in place warning of the danger of submerged objects when the lake level was low. In addition, its publication, *Lake Tekapo Navigation Safety Bylaws Pamphlet,* warns: "Be aware of hazards – the water may hide submerged snags and rocks."

60. As a result of this accident, ECAN promptly posted specific warning signs in the area.

61. ECAN knows of some navigational hazards on Lake Tekapo, including a shallow area 200m north-east of Motuariki Island, which is marked by a PVC pipe. This area has not been accurately surveyed, but is described as being shallow enough to walk out to. It was from this area that the body of the deceased passenger was recovered.

Ability to communicate distress

62. The occupants of ***Blue Dolphin*** relied solely on cellphones as a means of communicating their distress. Only having one means of communication is not considered good practice, as the more means of communication carried, the greater the chance of contacting someone and being rescued.

63. With the occupants of ***Blue Dolphin*** suddenly finding themselves in the water, any effective means of communication would have had to have been carried on their person, not left in the boat. In this instance, a personal locator beacon (PLB) carried on a lifejacket would have significantly increased the occupants' chances of being recovered from the lake.

64. VHF radio coverage is available on Lake Tekapo on channel 65, but this area is not monitored. Receipt of an emergency call on this channel would only be coincidental and cannot be relied on entirely.

65. Discussion and advice on communications equipment can be found in the MNZ publication *Safe Boating: An Essential Guide.* This is produced by MNZ, Coastguard and Water Safety New Zealand and is available free at www.maritimenz.govt.nz. Appendix 1 of this report reproduces MNZ's website information about communications and provides additional commentary about this topic.

Lifejackets/buoyancy aids

66. ***Blue Dolphin*** was known to carry:

- two Body Glove 405 buoyancy garments, size XXL
- one Body Glove 405 buoyancy garment, size large
- two RFD 402 PFDs.

67. One of the XXL buoyancy garments was located approximately 200m from ***Blue Dolphin***. The other XXL buoyancy garment and the two PFDs were found stowed in the bow. The size large buoyancy garment has not been found. It will most likely never be determined whether or not this buoyancy garment was being worn. However, if it was being worn, the search team would probably have located the wearer floating in the water.

68. The Body Glove buoyancy garments were relatively new and in good condition. The RFD PFDs were old and well worn, although still functional. The reflective tape on the two PFDs had lost any reflective ability.

Figure 19 Two PFDs and the Body Glove buoyancy garment

69. Type 405 buoyancy garments are not designed to act as modern lifejackets and are more suited to activities such as water skiing, where a person is expected to float for only a short period before being picked up again. They are not designed to turn an unconscious or injured person so that they are floating face up. These garments, as the label describes, are suited for:

> *constant wear during high activity water sports.*

70. The label further warns:

> *May not be suitable for all conditions – For use where early rescue is anticipated.*

71. Although far from ideal, the buoyancy garments, if worn, would have been better than nothing. Had the occupants of ***Blue Dolphin*** donned these before getting underway or when the conditions deteriorated, they would have significantly increased their chances of being rescued or recovered.

72. The 1989 NZ Standard 5823:1989 applies to the PFDs found on ***Blue Dolphin*** and provides the following standards and definitions:

> *Sheltered Waters Lifejacket: A buoyancy aid worn on the body which is intended to maintain the wearer in a safe floating position and for use in sheltered waters where early rescue may be anticipated. Lifejackets may incorporate provision for protection against hypothermia.*
>
> *402.1: Scope – This section sets out the requirement for lifejackets anticipated for use in small boats in sheltered waters where early rescue may be expected.*

73. The standard does not provide a further definition of 'sheltered waters', although it is likely that this is intended to describe waters that are protected from the weather. This could include small lakes, harbours and estuaries, but is unlikely to include a large open lake such as the one in which ***Blue Dolphin*** was operated.

74. The phrase 'where early rescue may be anticipated' is also somewhat ambiguous, but it is likely that this is intended to describe situations where other vessels or support craft are likely to be present – for example, an organised yacht race, a joint fishing trip involving two or more vessels, or an occasion where the participants have radio contact with other vessels nearby.

75. With only cellphones for communication, expecting an early rescue in ***Blue Dolphin***'s circumstances would be unrealistic. Nevertheless, wearing the type 402 PFDs would have been better than wearing no lifejackets. If the occupants of ***Blue Dolphin*** had been wearing these PFDs, they would have significantly increased their chances of being rescued, recovered, or even possibly making it to shore.

76. Best practice would have seen the skipper and passengers wearing auto-inflating 401 open-waters lifejackets. Being inflatable, these are less bulky than a 402 PFD and are automatically inflated when the wearer is immersed in water. The auto-inflation of the lifejackets allows for an unconscious person to be held afloat in an upwards-facing position with their airways clear of the water.

77. Discussion and advice on the various types of lifejacket, buoyancy aid and PFD can also be found in the publication *Safe Boating: An Essential Guide.* Appendix 2 of this report reproduces MNZ's website information about lifejackets and provides additional commentary about this topic.

Autopsy report

78. The pathologist's report revealed that the passenger recovered from the water had injuries consistent with having been thrown from the vessel and struck by it as it passed over him. Asphyxiation due to drowning was listed as the cause of death. The pathologist also commented on the nature and extent of the passenger's injuries, noting that even if he had been rescued, he may not have survived those injuries. The autopsy confirmed that alcohol was not a factor in this accident.

Surviving cold-water immersion

79. In this case, drowning and hypothermia would only have been risks to the occupants of ***Blue Dolphin*** had they survived the collision and the shock of being suddenly immersed in cold water. However, the circumstances of this accident may never be determined.

80. The anticipated survival time in water of 8.5°C is up to two hours. This survival time is significantly reduced when lifejackets are not worn; or the victims are injured, lose consciousness or have pre-existing health conditions; or body heat is lost through inadequate clothing and attempts to swim (see Appendix 3).

81. Without the recovery of the bodies of ***Blue Dolphin's*** skipper and remaining passenger, the investigation is unable to make any further comment on the effects of cold-water immersion in relation to this accident. However, it is highly recommended that every recreational boater should be adequately prepared for an emergency situation. When boating in cold water, and where a person enters the water by accident or emergency, slowing the onset of hypothermia is crucial to survival. Some safety measures to be taken include:

- wearing lifejackets or PFDs suitable for the environment
- wearing several layers of warm clothing with a watertight outer layer
- carrying several suitable means of quickly and effectively communicating distress
- training, practice and experience with the essential safety equipment prior to entering the water
- avoiding entering the water, if at all possible.

82. Appendix 3 contains general information about the effects of unplanned immersion in cold water.

Conclusions

83. The following conclusions have been drawn from the information obtained during this investigation:

84. ***Blue Dolphin*** collided with a solid object while underway. It is likely that all three men were involuntarily ejected from the vessel at the same time, and the vessel carried on without them. One passenger was injured in the collision and it is possible that the skipper and remaining passenger were also injured. It is estimated that this collision took place at about 12.30pm.

85. The emergency stop switch was not attached to the skipper. Once he and the other passengers had been ejected, the vessel was left in full throttle to carry on until she ran aground on the shingle bar where she was later located.

86. If they survived the collision and cold-water shock, the skipper and passengers had an anticipated survival time of up to two hours. The rescue commenced at about 10.30pm, by which time the skipper and passengers would have most likely succumbed to the fatal effects of cold-water immersion.

87. Their cellphones were not used, because they were most likely inoperable. If any of the following had been available to the occupants of ***Blue Dolphin***, a search and rescue operation could have been coordinated almost immediately, possibly increasing the survival chances of the skipper and passengers, or the chances of them being recovered:

- EPIRB or PLB, particularly those with integrated GPS
- hand-held VHF, either waterproof or kept in a waterproof covering that permits the radio's use without removal
- marine distress flares.

88. Wearing suitable lifejackets would have significantly increased the occupants' chances of being rescued or recovered.

89. Although buoyancy garments and PFDs were carried, 401 open-waters lifejackets, such as an inflatable, would be more appropriate on a large body of water like Lake Tekapo, which is exposed to the high-country weather.

90. The skipper and passengers were not adequately prepared for a cold-water survival situation.

Recommendations

91. It is recommended that MNZ, working through the NPBSF:

a) continues to foster, in line with the NRBSS, the carriage of effective emergency equipment by way of:

i) a national safety awareness campaign, and

ii) the introduction of legislation making the carriage of communications equipment in recreational craft compulsory

b) continues to promote, through the recreational boating community:

i) the safe use of lifejackets/PFDs

ii) the correct methods for in-water survival techniques

iii) the effects of hypothermia and the steps that can be taken to reduce its onset

iv) the need to be prepared for any emergency situation, and the value of assessing the associated risks and implementing contingency plans to mitigate such risks

v) the need to carry several forms of communication.

Appendix 1: Ability to communicate distress

(Retrieved from Maritime New Zealand's website at www.maritimenz.govt.nz)

Communications equipment is an essential part of safe boating – put simply, if you cannot contact someone to say you are in trouble, nobody can rescue you.

In the maritime environment, if a person finds themselves in an emergency or distress situation, one of the key factors to survival is the ability to communicate their situation and position to emergency services by the fastest means available.

This will not only inform the search and rescue services of the distress, but will also help to direct the appropriate resources to the distress position.

There are several methods of communicating distress, and it is recommended that as many of these as possible should be carried – two methods of communicating should be the absolute minimum. Communication methods include:

Very high frequency (VHF) radio (portable or fixed):

VHF radio is a good way of relaying a distress message to the emergency services or other boat users when one is close to the land. However, there are some disadvantages. It if is a fixed radio and the boat sinks rapidly there may not be time to transmit a mayday call. Once the boat has sunk, the radio is rendered inoperable.

Portable VHF radios may be kept on the person and used in the water; however, they need to be waterproof and have sufficient range to communicate with search and rescue services.

Maritime VHF radios operate on the Marine Radio Band. They do not operate on other VHF frequencies, such as the military or civilian bands.

The transmitting and receiving of messages via VHF relies on line-of-sight communications. That is, that the line between the aerials is not interrupted by things such as hills. Because of that, geographical features can result in 'blind spots' where there is no coverage.

The more power a radio has, the better it will function and the further it will transmit. Without power, they will not work. The radio frequency also travels better over water than it does over land. All of these things should be considered when purchasing a VHF radio.

Cellphones:

Cellphones are a communication option; however, if the phone is not protected from the water it is likely to fail. A sealable plastic bag can provide some protection and allows the phone to be used without exposing it to the water.

Use of a cellphone is also reliant on the cellphone range and network. Cellphones are not designed for maritime emergencies, and using one may be difficult in a dynamic environment such as a choppy seaway.

Maritime distress flares (rocket, handheld and smoke):

Flares are a good communication option. Red rocket flares are designed so they can be used both day and night. While they do not pinpoint a person's location, they give a general search area if seen by a passing vessel or person ashore.

Rocket flares should not be used if an aircraft is in the immediate vicinity. Burning time is about 40 seconds, with visibility up to 15km during the day and up to 40km at night.

Hand-held flares are good for indicating a distress position for approaching search and rescue craft by sea and air, and they pinpoint a person's position by way of the red flare's illumination.

Smoke flares are for daylight signalling use. They are a good means of pinpointing a location by way of a bright orange smoke signal, but are of no use during the hours of darkness.

Hand-held signal equipment: Hand-held strobe lights are a communication option. They are visible 2.4–3km at night and can assist vessels or aircraft in the vicinity by pinpointing a person's location.

Specifically designed strobe lights are waterproof and come with a Velcro strap that can be used to attach the light to such things as a lifejacket.

Distress beacons: With the advent of modern communication under the Global Maritime Distress Safety System (GMDSS), the use of an emergency beacon, such as a 406MHz Personal Locator Beacon (PLB) or a 406MHz Emergency Position-Indicating Radio Beacon (EPIRB), is a reliable way of alerting search and rescue services that a person is in distress and requires immediate assistance.

Some EPIRBs and PLBs are equipped with a GPS input. The GPS position is sent with the distress beacon signal, providing search and rescue services with a pinpointed geographical location of the distress position. EPIRBs and PLBs are readily available for recreational or commercial use in New Zealand.

Most EPIRBs are 'float free' and designed to break away from a foundered vessel and activate.

Most PLBs are waterproof and shockproof. They commonly come in neoprene pouches that can be attached to a lifejacket.

One of the functions of GMDSS is to monitor beacon distress frequencies via satellite. It is a 24/7 operation and operates worldwide. A brief explanation of how it works is:

1. A distress beacon is activated.
2. The signal is transmitted to the nearest sub-orbital satellite. These are satellites that remain in stationary position over the same area of the Earth's surface, or that are constantly circling the Earth in polar orbits.
3. The signal is transmitted from the satellites to the nearest local user terminal (LUT). These are placed around the globe, to ensure signals are received almost immediately.
4. In New Zealand, the signal is passed to the Rescue Coordination Centre New Zealand.
5. RCCNZ mobilises rescue resources and directs them to the coordinates of the signal.

If the beacon is using the 406MHz signal, GMDSS consists of four geostationary satellites located above the equator at intervals of approximately 120° of longitude. The satellites can 'see' from approximately 70° North to 70° South.

If, however, the beacon has GPS input, RCCNZ will receive notice of activation of the beacon and the position of the distress within approximately 10 minutes of it being activated (see Figure A1.1 – diagram of COSPAS-SARSAT system overview).

The satellites process only 406MHz signals and will detect a transmission, if it is not blocked by terrain, the instant a 406MHz beacon is activated. RCCNZ will then receive processed information within approximately four minutes of activation. If no Doppler position is available, RCCNZ may have to wait until a LEOSAT satellite is in the area before position information is obtained.

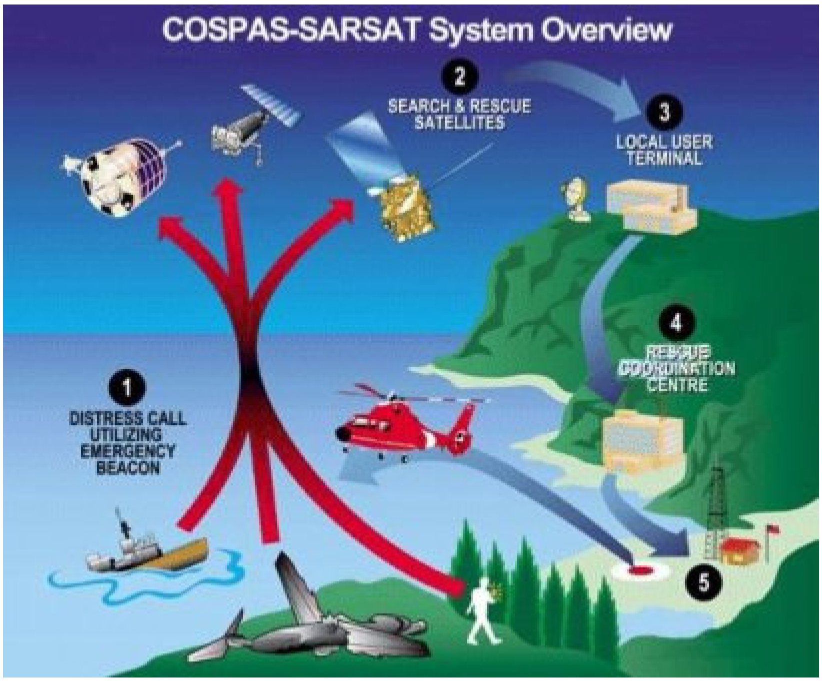

Figure A1.1 How the COSPAS-SAESAT system works

Costs of PLBs/EPIRBs

The following is an indication of retail prices for PLBs in 2008 .

406MHz PLB

Manual	$620
Integral GPS, manual	$699
Integral GPS, manual and strobe	$750
Manual and water-activated	$695

The following is an indication of retail prices for EPIRBs in November 2008.

Water-activated/manual, integral GPS	$849
Non-GPS, manually activated	$285+ (depending on model)

Figure A1.2 Example of a float-free EPIRB

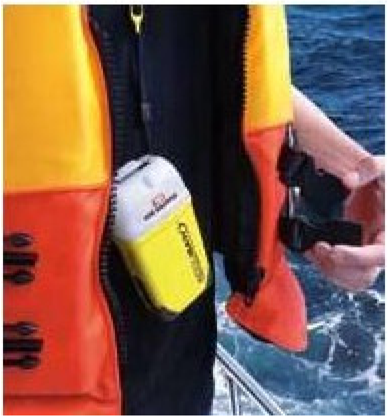

Figure A1.3 Example of a PLB attached to a lifejacket

For distress communications equipment to be useful, it should be carried in a waterproof 'grab bag' that is easily accessible, highly visible, buoyant, and stowed where it will float free from a sinking vessel.

Figure A1.4 Example of a buoyancy grab bag

Figure A1.5 Example of a buoyancy grab bag

More information about communicating distress is available at www.maritimenz.govt.nz.

Appendix 2: Lifejackets

(Retrieved from Maritime New Zealand's website at www.maritimenz.govt.nz)

A lifejacket is a device that, when used in the water, is designed to provide specific buoyancy, to position and keep an unconscious person's head and airways clear of the water. There are various types of lifejacket on the market, which are outlined in this appendix.

Lifejackets, if properly worn and in good condition, provide much more support than a personal flotation device (PFD) and are purposely designed for in-water sea survival.

The buoyancy provided by a lifejacket will make it easier to maintain an in-water sea survival position. The resulting reduction in use of energy is important in delaying the onset of hypothermia.

Lifejackets are generally rated to provide either 100 or 150 Newtons (N) of buoyancy.

They are intended for rougher waters and are fitted with reflective tape, a whistle and, on some lifejacket brands, an optional light. For buoyancy, these lifejackets can be made from inherently buoyant material or have gas-operated chambers.

A type of lifejacket, known as a SOLAS lifejacket, is compulsory on SOLAS[1] ships in New Zealand and is intended for emergency use in all weather conditions. SOLAS lifejackets are equipped with reflective tape, a whistle and a light, and some are also fitted with splash hoods to protect the head and airways in rough sea conditions.

PFDs and buoyancy aids

There are many types of buoyancy aid on the market, including what are commonly known as personal flotation devices (PFDs). A buoyancy aid is a device made from inherently buoyant material that helps the wearer remain afloat in the water.

PFDs are intended to help the wearer stay on the surface by supplying additional buoyancy to the person's body. They are generally designed for use in sheltered waters, where the shore and help, if needed, is close to hand.

PFDs are not designed to the same standard as lifejackets, and are not intended to be used in an extended sea survival situation because they provide less buoyancy to the wearer. They will not right an unconscious wearer and bring the person into a stable position in the water, keeping their airways clear.

Buoyancy aids are generally designed to supply between 51N and 100N for a person who weighs more than 40kg.

Standards

NZ Standard 5823:2005 defines lifejackets and buoyancy aids as follows:

- Category 401 – open-waters lifejacket (previously referred to as a 'coastal lifejacket')
  A buoyancy aid worn on the body, which is intended to maintain the wearer in a safe floating position and for use in rougher waters, instead of an inshore-waters PFD. It may incorporate provision for protection against hypothermia.
- Category 402 – inshore-waters PFD (previously known as 'inshore-waters lifejacket')
  A buoyancy aid worn on the body, which is intended to maintain the wearer in a safe floating position and for use in inshore waters where early rescue may be anticipated. PFDs may incorporate provisions for protection against hypothermia.

[1] SOALS vessels are required to comply with the Safety of Life at Sea Convention 1974. Generally, these are ships that engage in international voyages.

- Category 403 – buoyancy vest

  A buoyancy aid worn on the body and intended for use in aquatic sports, to assist in flotation during short-tem immersion in smooth waters.
- Category 404 – buoyancy aid wetsuit

  A wet suit with added buoyancy, intended for use in aquatic sports where hypothermia and frequent immersion in water may place the wearer at risk.
- Category 405 – buoyancy garment

  A buoyancy aid other than a lifejacket, PFD or buoyancy vest, worn on the body and intended for use where the wearer is at risk of immersion in water.

Scope of use

Each category is designed for different areas of intended use. The specifications for each category set out the requirements for these areas of use. These, along with other specific warnings, must be displayed on the label of each lifejacket or PFD.

NZ Standard 5823:2005 defines the scope as follows:

- Category 401 – open-waters lifejacket (previously referred to as a 'coastal lifejacket')

  …anticipated for use in boats in open waters where early rescue may not always be expected.
- Category 402 – inshore-waters PFD (previously known as 'inshore-waters lifejacket')

  ...devices anticipated for use on inshore waters where early rescue may be expected.
- Category 403 – buoyancy vest

  …intended to be worn on the body to assist in flotation during short-term immersion in smooth waters.
- Category 404 – buoyancy aid wetsuit

  … to be worn on the body to assist in flotation and to conserve body heat when the wearer is at risk of short-term immersion in water.
- Category 405 – buoyancy garment

  …intended to be worn on the body when the wearer is at risk of short-term immersion in water.

The standard does not provide any further definition of what is meant by 'open waters', but this can be reasonably interpreted to mean the open sea or an area that is not close to the shore. This includes areas such as the ocean, coastal areas, straits, large lakes, or areas that are fully exposed to the elements and are not provided protection from the land.

Likewise, the standard does not provide any further definition of what is meant by 'sheltered waters', although it is most likely that this is intended to describe waters that are sheltered from the elements. This includes small lakes, harbours, and estuaries, and does not refer to the open water.

The phrase 'where early rescue may be anticipated' is somewhat ambiguous, but is most likely intended to describe situations where other vessels or support craft are likely to be present. For example, this could include such things as an organised yacht race, a joint fishing trip involving two or more vessels, or an occasion where the participants have radio contact with other vessels nearby. All boaties should always be prepared for the worst and not rely on 'early rescue' simply because they have a means of communicating their distress or have logged a trip report.

The term 'short-term immersion' is not defined further, but is considered to refer to situations where a person is going to be returned to their craft quickly. This would include situations such as a water-skier waiting for the boat to turn around and pick them up, or a windsurfer who falls off their board.

It is important to note that the standard's definitions do not take water temperature into consideration. Water temperature will have a significant effect on whether or not a rescue could be considered 'early' or what 'short term' is. For example, short-term immersion in cold water can kill, and for a rescue to be considered 'early' it would have to be within minutes, not hours.

Selecting the right lifejacket or PFD

It is imperative that the correct type of lifejacket or PFD, which is suitable for the circumstances, is carried. When it comes to safety, erring on the side of caution is recommended, and one should always aim for the higher standard rather than the 'she'll be right' approach.

Consideration should be given to:

- the intended area of use
- how bad the weather can get in that area
- the lowest water temperature you could expect to encounter
- how much time you could potentially spend in the water
- the amount of buoyancy offered
- how visible your lifejacket/PFD is
- whether it is comfortable enough to wear constantly.

Remember that your survival may one day depend on the quality of your lifejacket or PFD, and caution is recommended when purchasing one of these second hand.

Take heed that many old PFDs are advertised as lifejackets when they do not meet the required standard. Older, kapok-style PFDs should be treated with great caution and avoided if possible. Ensure that the second-hand PFD or lifejacket does not leak and the reflective tape still holds its reflective properties.

The examples on the following page show PFDs that, at the time of writing, were advertised as lifejackets and were all for sale for $5 or less. Although better than nothing, these items are not in good order and have passed their usefulness.

Figure A2.1 $5

Figure A2.2 $3.50

Figure A2.3 $3.50

Figure A2.4 $3.50

Boaties should ask themselves,” How much is my survival and the survival of my children worth?” before purchasing a PFD or lifejacket.

Correct use

A buoyancy aid or lifejacket will only be effective if:

- the right category and model is used, in accordance with the manufacturer's instructions and in the intended area of use, namely open sea or inland/sheltered waters
- the right size of lifejacket or aid is chosen, according to the weight and size of the person wearing it
- it is donned in accordance with the manufacturer's instructions
- it is worn at all times while in the sea
- it is in good working condition.

A properly fitted lifejacket is vital in situations where people in the water become tired, hypothermic or lose consciousness.

Lifejackets have a tendency to 'ride up' if they are not fitted correctly, and this makes staying afloat difficult. It is recommended that you test a new lifejacket under safe conditions to ensure it performs as you expect it to and that it fits.

The photographs below show a 401 lifejacket fitted correctly (Figure 5) and incorrectly (Figure 6).

Figure A2.5 A correctly fitted 401 lifejacket

Figure A2.6 An incorrectly fitted 401 lifejacket

To provide an example of this, MNZ investigators tested this 401 lifejacket when it was incorrectly fitted. It was found that the front section came loose from the chest, with the strap going under the wearer's chin. The wearer remained face down in the water, allowing the airways to be submerged (see Figure 7).

Figure A2.7 The incorrectly fitted lifejacket turned the wearer face down

Inflatable lifejackets/PFDs

Lifejackets may be manufactured from inherently buoyant material or they may be inflatable. Generally, inflatable lifejackets have a minimum buoyancy of 150N, which is 50N higher than lifejackets made from inherently buoyant material.

Inflatable lifejackets are not usually bulky and are comfortable to wear constantly. For example, they are comfortable enough to wear over the top of a wetsuit, whereas a 150N lifejacket made of inherently buoyant material is unlikely to be.

Inflatable lifejackets are inflated by a CO_2 gas cylinder held within the jacket. This is either activated manually by the wearer pulling a tab, or automatically through immersion in water.

It should be noted that auto-inflating lifejackets can still be inflated manually. In other words, they do not necessarily require the wearer to be immersed in water and can be activated in anticipation of this happening.

When an unconscious wearer enters the water, an auto-inflating lifejacket will inflate and is designed to keep their airways clear of the water. However, some caution must be exercised when using auto-inflating lifejackets that the wearer is not in an enclosed space, such as a cabin, when the jacket is immersed in water and inflates. This could result in the wearer being trapped and unable to escape to safety.

Manually inflated lifejackets require the wearer, or a person assisting the wearer, to be conscious and capable of activating the inflating mechanism. The benefit with these is that the wearer can control when the lifejacket is inflated, which is appropriate for people who are likely to be spending time in a wheelhouse, cabin or similar enclosed space.

All inflating lifejackets have a service requirement. The service must be conducted by an approved person and carried out every two years. It is also recommended that the lifejacket is washed after use, and regular checks are made to ensure the CO_2 canister is not loose, rusty or showing signs of deterioration.

There is no requirement for other types of lifejackets (non-inflatable) to be serviced or tested. However, an emergency situation is not a good time to learn that your lifejacket is not up to standard or suitable. It is recommended that lifejackets or PFDs are trialled in a safe environment before they are relied on in an emergency situation. This could simply involve wearing it in a swimming pool to ensure it fits and performs as expected.

Crotch straps

Lifejackets and PFDs can ride up or even come off when not fitted properly or used in rough waters. A lifejacket or PFD that rides up can cause significant discomfort and impede breathing. To eliminate this, crotch straps can be fitted to most lifejackets or PFDs. These are highly recommended.

There is a requirement for all children’s lifejackets/PFDs to be fitted with crotch straps.

The standard recommends that manufacturers supply attachment points for the fitting of crotch straps. It also recommends that all 401 and 402 buoyancy aids are retro-fitted with crotch straps. However, this is only a recommendation, not a requirement.

Visibility and colour

A 401 standard lifejacket must meet certain colour requirements specified in the standard. Generally, these are highly visible colours. They must also have reflective tape attached in two places, as high as possible on the lifejacket. The tape is designed to reflect light and aid rescuers searching at night.

Reflective tape loses its ability to reflect light over time and through exposure to weather and water conditions. When the reflective tape on a lifejacket has lost its reflective properties, the lifejacket should be replaced.

402 PFDs must have the same colour standard as a 401 on the upper area of the PFD. The remainder of the PFD can be any colour. They also have the same requirement to have reflective tape attached.

403 PFDs have the same colour requirements as 402 PFDs.

404 buoyancy aid wetsuits have rather prescriptive colour requirements, which are similar to the 401 standard. However, the colour need only be in certain areas, and 25mm of reflective material must be attached to the shoulder areas.

The 405 buoyancy garment has no colour requirements. The standard simply says that it may contain areas of colouring according to the requirements of a 401 lifejacket. The key point here is that it does not say that it must. There is also no requirement for reflective tape to be fitted, only that if it is, it should meet the requirements of a 401 lifejacket.

Being highly visible in the water increases a person's chances of being rescued. Note the worn colouring and reduced visibility of the second-hand PFDs in the photographs shown above. Unfortunately, buoyancy garments are sometimes made in colours that look good, like blue or grey, but do nothing to increase visibility. When purchasing a lifejacket/PFD, it is recommended that safety takes precedence over appearance and bright coloured lifejackets/PFDs are selected.

Other features

There are several other features that may be added to a lifejacket/PFD that are well worth considering. These include:

- a whistle – these are only a requirement on 401 lifejackets, but good practice would be to carry one all buoyancy aids
- a 'D' ring – these are designed for attaching a rescue rope or winch (Some brands offer these as an alternative to their standard models.)
- a fixing point that a personal locator beacon (PLB), strobe light, cyalume stick (glow-stick) or torch can be attached to
- a pocket or pouch that can carry an assortment of items, such as a neoprene hood, flares, PLB, cellphone in plastic bag or cyalume sticks
- a splash hood.

Appendix 3: Cold-water immersion

Part 1 – Surviving cold-water immersion

(Adapted from Golden, F. and Tipton, M., *Essentials of Sea Survival,* 2002, ISBN 10:0-7360-0215-4 Human Kinetics)

Each year, 140,000 water-related deaths occur worldwide, and in the UK 55% of the annual open-water immersion deaths occur within 3m of a safe refuge. Significant international research has been undertaken to establish why some people survive cold-water immersion when others do not. First, there appears to be a general lack of understanding by seafarers of the nature of the various threats and the reaction of the body (physiological responses) to them. Second, in a survival situation, safety equipment is often not readily to hand, is difficult to operate in adverse conditions, or is impossible to use correctly without specific training. Survivors are often left to their own devices to adapt to the situation as best they can.

Predicting survival times in immersion victims is not a precise science. No magic mathematical formula can determine exactly how long someone will survive or how long a rescue search should continue. Therefore, search and rescue (SAR) coordinators must make some tough decisions based on the best information available and a number of assumptions. Search times typically extend beyond that which a person can reasonably be expected to survive in the circumstances. A rule of thumb is for search times to be at least three to six times the predicted survival times.

In water at 5℃, the survival time for a normally clothed individual is estimated to be about one hour with a recommended search time of six hours. The corresponding times for water at 10℃ are two hours and 12 hours. For water at 15℃, it is six and 18 hours. However, these survival times are highly variable and are influenced by many different factors:

1. **Water temperature**. As the above figures suggest, the colder the water, the shorter the survival time.

2. **Conditions**. Choppy water is more difficult for survivors to deal with than calm water, with many people panicking or even drowning from waves splashing over their heads.

3. **Personal factors**. Gender, size, fitness, health, age and shivering response all influence survivability. Statistically, the very young and very old are less likely to survive prolonged immersion in cold water than a mature adult. A fatter person will survive for longer than a skinny person due to the greater subcutaneous fat layer beneath the skin, which helps insulate the body from heat loss. Pre-existing health conditions may be exacerbated by cold-water immersion.

4. **Insulation**. Clothing will significantly influence survivability. People dressed in several layers of heat-insulating clothing with a waterproof outer layer will last for longer in cold water than those who are lightly dressed. A popular misconception is that drowning is caused by the weight of saturated clothing 'dragging people under'. This belief has led to the misguided advice to undress in the water, an action that reduces total insulation.

5. **Posture and exercise**. By limiting the amount of movement undertaken, there will be a corresponding reduction in the amount of heat loss from the body. Drawing the limbs up close to the body, adopting a foetal position, and keeping them there is considered to be the ideal posture for prolonged cold-water immersion.

6. **Injuries**. Many people who enter the water are injured before they do so, and they are sometimes knocked unconscious. The extent of the injuries will significantly affect survivability.

7. **Personal flotation device (PFD)**. Staying afloat without having to swim or tread water will reduce the amount of movement required by survivors. For those who lose consciousness, wearing a suitable PFD will ensure they remain above the surface of the water and do not drown.

8. **Communications**. The sooner the rescue, the greater the chances of survival. But the outside world needs to know an accident has occurred and that can only be via effective planning and communications. Shore-based people should be briefed of the vessel's intentions before departure. A PLB, EPIRB, VHF radio, flares or even a cellphone in a sealed bag can be used to let others know an emergency situation has occurred.

9. **Ability to operate equipment**. Within a short period of time (often minutes or even seconds) after immersion, it can become extremely difficult to perform even simple tasks. Fingers become numb and 'seize up', so closing a zip, attaching a clasp or even raising a hand and waving can be impossible to achieve. Some survivors speak of the frustration of having safety equipment like a PLB available, but not being able to operate it because their fingers were so numb.

Long-term survival will generally only occur when the survivors are protected from the elements inside a life raft, or they are at least out of the water, reducing the amount of heat loss. Water and food is only an issue when prolonged survival is required before rescue.

While it should not be underestimated, hypothermia is attributed as the cause of death more than it should be. It generally occurs some time after initial immersion and victims are more likely to succumb to their injuries, lose consciousness and/or drown than they are to die of hypothermia.

Approximately 20% of rescued survivors die during or shortly after rescue (circumrescue collapse). This results from a collapse of blood pressure, an increase in the work rate of a cold heart when aiding one's own rescue (for example, climbing ladders on a high-sided ship) and/or excessively rapid rewarming (rewarming collapse).

Recommendations

1. Be prepared for the worst. Ensure all the equipment described earlier is aboard and functioning correctly. Regular training by everyone on board will ensure it is used correctly. Trying something for the first time once an emergency exists is not a safe option.
2. Avoid entering the water in the first place. Ensure others on board are capable of performing a speedy and effective man-overboard recovery if required. Only abandon the vessel if necessary, and try to do so without entering the water (for example, step into a life raft while remaining dry). If entering the water is unavoidable, try to do so slowly to prevent cold shock and rapid body temperature loss.
3. Wear a PFD. Don't rely on retrieving it in an emergency or having the ability to put it on. Many victims have PFDs aboard their vessels but cannot reach them, or they lose the ability to fit them once they enter the water.
4. Wear as much clothing as possible and try to ensure that the outer layer is watertight, protecting as much of the skin as possible from coming rapidly into contact with the water.
5. Stay still in the water and adopt a foetal position.
6. Complete any survival actions that require manual dexterity and strength soon after immersion, before it becomes impossible to do so. Don't underestimate the speed with which incapacitation can occur.
7. Upon rescue, victims should be positioned to offset any potential problem in maintaining blood pressure. In a boat, the victim should be laid feet-forward, head-aft, but in a helicopter it is the opposite. Immediate competent medical attention is essential to survival.
8. Where possible, rewarming should be slow. A rate of 0.5^{o}C to 1^{o}C per hour is the safest option.

Part 2 – Survive in cold water

(Retrieved from the MNZ website at www.maritimenz.govt.nz/Recreational-boating/Lifejackets/Survive-in-cold-water.asp on 19 November 2009. Adapted from *Safety in Small Craft* by Mike Scanlan, Coastguard Boating Education)

Cold is one of the greatest threats to the lives of everyone on the water. Certain techniques can improve your chance of surviving long enough to be rescued.

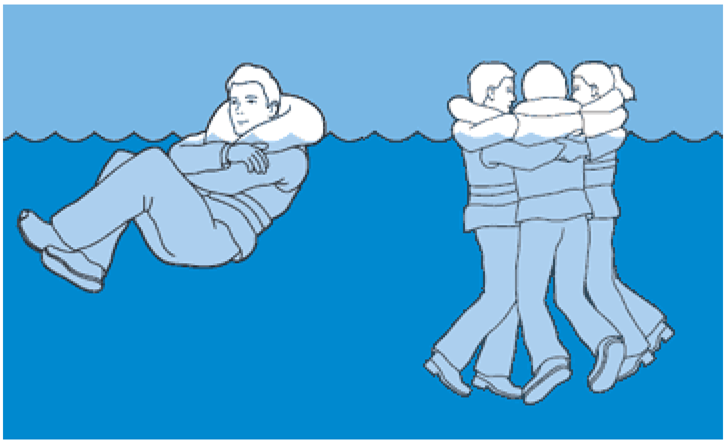

Figure A3.1 The 'HELP' (left) and 'Huddle' positions

The aim of the 'HELP' and 'Huddle' positions is to keep the warm water close to the body from being replaced by colder surrounding water.

Cold is one of the greatest threats to the lives of everyone on the water. The human body is designed to operate best at about 37°C. Just a couple of degrees are all it takes to throw that equilibrium off balance, and at 30°C to 32°C, death is almost assured.

In waters of 10°C, the average person will be semi-conscious or unconscious within one hour. Death from drowning will often occur within two hours, even with a lifejacket. In waters of 15°C, a person might survive for up to six hours.

The greatest threat from cold is hypothermia. In cold, the body first prioritises the vital organs – the heart, lungs and brain – to enable them to function normally. It reduces warm blood flow to the outer layers of the body and the extremities. Hands and feet feel cold, and shivering starts in an involuntary attempt to generate more heat.

As the body's core temperature drops, the vital inner organs also become affected. As the brain cools, consciousness is affected. Without correct treatment, death will follow.

Cold can also kill quickly. The shock of suddenly entering very cold water can cause a large gasp for air and a massive increase in lung and heart effort. This alone can result in muscle spasm, drowning or heart attack.

Many of New Zealand's seas, lakes and rivers are very cold. While the effects of immersion in cold water vary depending on factors such as body fat, strength and attitude, certain techniques can improve your chance of surviving long enough to be rescued.

Here are some of the things you should do to improve your chance of survival:

- **Wear a lifejacket.** A full lifejacket helps to keep the head and airway clear of the water, even when strength and mental capacity is waning. It will also make adopting heat loss-reducing postures much more stable.

- **The more clothes you have on, the better.** Do not get undressed to enter the water. If there is time, add more layers. A person wearing two layers of woollen clothing will lose less than a quarter of the heat a person wearing only a swimsuit will lose. Wear as many layers of wool as possible, covered with a waterproof layer. The wool will trap warmer layers of water closer to the body.
- **Try not to panic.** Panic can impair breathing and hasten the drowning process. Hyperventilation can occur when a person is unexpectedly immersed in the water. A mistimed breath can result in a laryngospasm, which sometimes results in loss of consciousness. A person who does not panic may simply have to cope with hyperventilation, which will eventually subside.
- **Where possible, get out of the water.** In water, the body loses heat 20 to 30 times faster than it does in air. Even if you feel colder out of the water, try to clamber on top of an overturned boat or any floating wreckage.
- **If you are forced to stay in the water, adopt the HELP (Heat Escape Lessening Posture).** Hold arms tight against the chest, press thighs together and raise up the knees to protect the groin. This posture will increase survival time by nearly 50%. It is easiest to adopt when wearing a lifejacket.
- **Groups of three or more should adopt the huddle position.** The sides of the chest and lower torso are pressed together, arms hugging each other around the lifejackets. Intertwine legs as much as possible, and talk to one another. Children succumb to cold much more quickly than adults, and should be sandwiched in the middle of the group.
- **Consider options before swimming to shore.** If you decide to swim for shore, consider that tests show an average person wearing a lifejacket and light clothing could swim about 1.85km in water of 10℃. In one case in Canada, a 20-year-old strong swimmer drowned within five minutes in 10℃ waters. When deciding to swim for it, consider your swimming ability, the weakening effects of the cold and anxiety, and the huge overall heat loss that the swim will cause. If in any doubt, stay with the boat.

How the body reacts to cold

The body must maintain the vital organs in its inner core – the heart, lungs, brain and so on – at a constant temperature of about 37.6℃ to enable them to function normally. At normal temperatures, the heat generated by the body is carried by the blood to all regions of the body. The body automatically regulates its blood flow to control body temperature. Any excess heat is removed by transferring it to the outer layers for dissipation.

As the temperature of the environment falls, the outer layers of the body begin to cool. The body now reduces blood circulation to these outer regions, so that the cooling is not transferred to the important organs in the deeper regions of the body. Hands and feet feel cold because of the reduced blood supply to these areas. Shivering starts as an involuntary muscular attempt to generate more body heat.

With further cooling, the inner core of the body now begins to cool.[1] This is the beginning of hypothermia. The blood supply to the body's outer regions is further reduced because the body now takes drastic measures to maintain the temperature of its vital organs. Shivering may decrease or stop. The organs in the core are now being affected. As the brain cools, there is reduced control and consciousness is affected. Further cooling of the core will cause the organs to stop functioning.

Consciousness is lost. Death will follow unless treatment is immediate and correctly given.

1 While progressive loss of body heat can result in loss of consciousness and death, many victims perish much sooner when immersed suddenly in cold water. Cold shock can affect some people, causing cardiac failure within a few minutes. Increased breathing rates can lead to dizziness and the muscles cool rapidly. Immersion in cold water can cause such rapid loss of muscular function that within minutes a person loses the strength to board a raft or even operate a flare.

A fit person in these circumstances quickly loses the ability to make even basic movements to help keep themselves afloat. There have been many recorded cases of drowning in less than 10 minutes – long before the body core temperature has started to drop or the person is affected by hypothermia.