CIVIL AVIATION AUTHORITY
OF NEW ZEALAND

AIRCRAFT ACCIDENT REPORT

CAA OCCURRENCE NUMBER 12/2242

HUGHES 369D

ZK-HXZ

CONTROLLED FLIGHT INTO LAKE

LAKE SUMNER

21 MAY 2012

Photo courtesy of www.nzcivair.blogspot.com

Foreword

Following notification of an accident or incident, CAA may investigate subject to Section 72B(2)(d) of the CAA Act which prescribes the following:

> **72B Functions of Authority**
>
> (2) The Authority has the following functions:
>
> (d) To investigate and review civil aviation accidents and incidents in its capacity as the responsible safety and security authority, subject to the limitations set out in section 14(3) of the Transport Accident Investigation Commission Act 1990:

The purpose of a CAA investigation is to determine the circumstances and identify contributory factors of an accident or incident with the purpose of minimising or reducing the risk to an acceptable level of a similar occurrence arising in the future. The investigation does not seek to ascribe blame to any person but to establish the causes of the accident or incident based on the balance of probability.

A CAA Safety investigation seeks to provide the Director of CAA with the information required to assess which, if any, risk-based regulatory intervention tools may be required to attain CAA safety objectives.

Contents

Glossary of abbreviations

CAA	Civil Aviation Authority of New Zealand
CAR (s)	Civil Aviation Rules
CPL(H)	Commercial Pilot Licence (Helicopter)
DOC	Department of Conservation
E	east
ft	foot or feet
HF	Human Factors
km	kilometre(s)
NIWA	National Institute of Water and Atmospheric Research
NZST	New Zealand Standard Time
PPL	Private Pilot Licence
RNZN	Royal New Zealand Navy
ROV	Remotely Operated Underwater Vehicle
SE	south-east
SMS	Safety Management Systems

CIVIL AVIATION AUTHORITY OF NEW ZEALAND

Data summary

Aircraft type, serial number and registration:	Hughes 369D, 1170233D, ZK-HXZ
Number and type of engines:	One Allison 250-C20B
Year of manufacture:	1977
Date and time:	21 May 2012, 1233 hours[1] (approximately)
Location:	Lake Sumner, North Canterbury Latitude[2]: S 42° 41' 40.26" Longitude: E 172° 13' 34.08"
Type of flight:	Aerial Work
Persons on board:	Crew: 1
Injuries:	Crew: 1 fatal
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence	Commercial Pilot Licence (Helicopter)
Pilot-in-command's age	36 years
Pilot-in-command's total flying experience:	3789 hours 517 on type
Investigator in Charge:	Mr P G Stevenson-Wright

[1] Times are NZST (UTC + 12 hours)

[2] WGS-84 co-ordinates

Synopsis

The Civil Aviation Authority (CAA) was notified of the missing helicopter at approximately 1515 hours on Monday 21 May 2012. The Transport Accident Investigation Commission was in turn notified shortly thereafter, but chose not to investigate. A CAA Safety investigation was commenced later that day.

The helicopter operator was contracted by the Department of Conservation (DOC) to conduct aerial spot spraying of weeds at various locations around the shoreline of Lake Sumner and along the banks of the Hurunui River where it flows out of Lake Sumner. The helicopter was reported as overdue when it did not return from its first spraying sortie. A search was commenced and debris from the helicopter was found floating in the lake approximately 450 metres west of the mouth of the Evangeline Stream. The CAA Safety investigation concluded that the most likely cause of the accident was controlled flight into the lake.

The CAA are exploring the possibility of publishing an awareness article regarding this accident with specific reference to the effects of spatial disorientation in respect to height and acceleration illusions.

1. Factual information

1.1 History of the flight

1.1.1 The helicopter operator was contracted by DOC to carry out spot spraying of weeds around the shoreline of Lake Sumner and the upper reaches of the Hurunui River where it flows out of the lake.

1.1.2 The local regional DOC Ranger and the helicopter's ground support crewman met the helicopter at approximately 1030 hours at a prearranged refuelling site, approximately 10 km south-east of the lake. An operational briefing was held before the three men undertook a 45 minute reconnaissance flight of the areas that were to be sprayed along the banks of the Hurunui River (refer Figure 1).

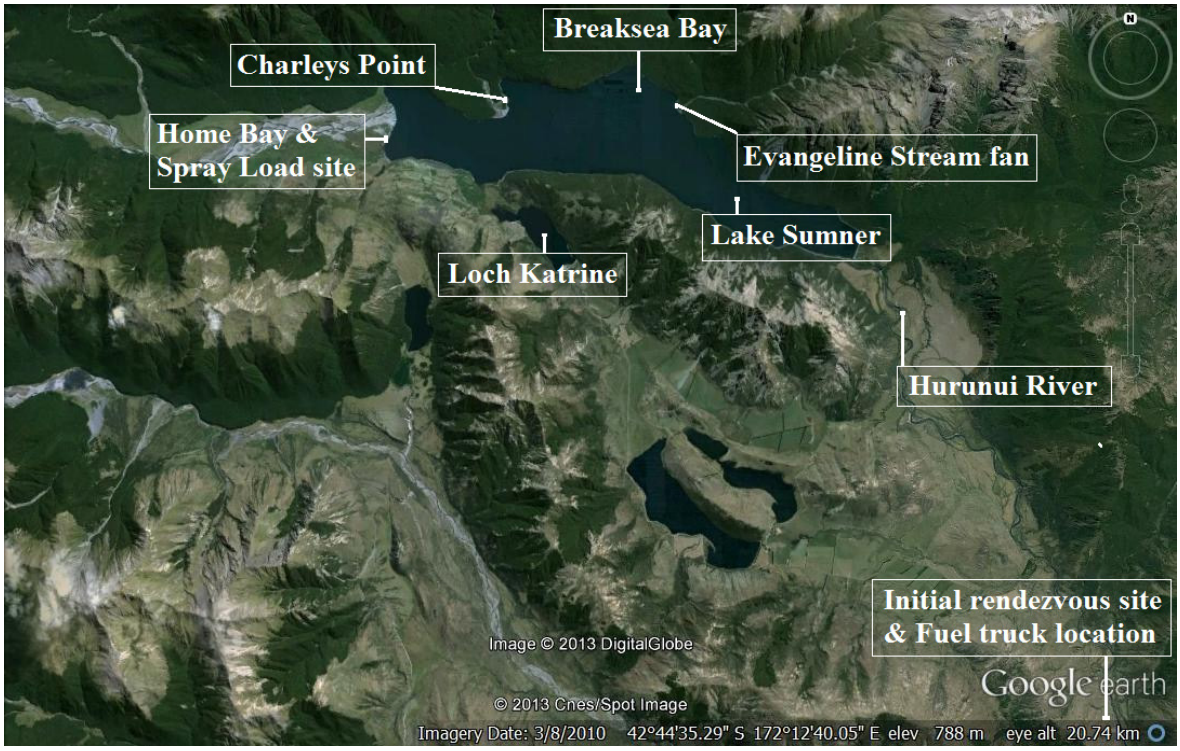

Figure 1.
Overview of Lake Sumner area

1.1.3 The helicopter returned to the landing site where more fuel was uplifted along with the chemicals and other equipment that would be needed later when spraying operations commenced. Another reconnaissance flight was conducted, this time around the lake, past the Evangeline Stream and Charleys Point, to Home Bay at the western end of the lake.

1.1.4 An appropriate loading site was chosen in Home Bay adjacent to a small stream. The helicopter was loaded with chemical product and the pilot departed on his first spray flight at approximately 1200 hours. This initially involved spraying in the Hurunui River area before moving back to the lake to spray numerous sites along the shoreline. The helicopter was not in sight and could not be heard by the men at the loading site while it was operating in the river area or at the eastern end of the lake.

1.1.5 When the DOC Ranger next heard the helicopter he observed it carrying out a spray run in the vicinity of the Evangeline Stream fan, 6 km away across the lake. He also saw that it was operating at low level and at a later stage appeared to be either hovering or flying towards him, before he looked away (refer Figure 2). The ground support crewman was busy preparing the next load of spray chemicals

and did not see the helicopter; however, he said he could hear it quite clearly. They both described the helicopter sound as being constant and normal.

1.1.6 Moments later both men heard a noise that caused them to take notice. They thought it "sounded like tools banging on the metal deck of a four wheel drive vehicle". Both men thought the sound had come from the Loch Katrine area, to the south-east of the loading site. The DOC Ranger said that as he turned to look in that direction he looked straight towards the Evangeline Stream area where he had last seen the helicopter, but saw nothing unusual.

1.1.7 Both men were sure they could still hear the sound of the helicopter for approximately 5 to 10 seconds after the banging noise stopped. The DOC Ranger also commented that there was no noticeable change in helicopter pitch sound from when he observed the helicopter spraying a few moments earlier.

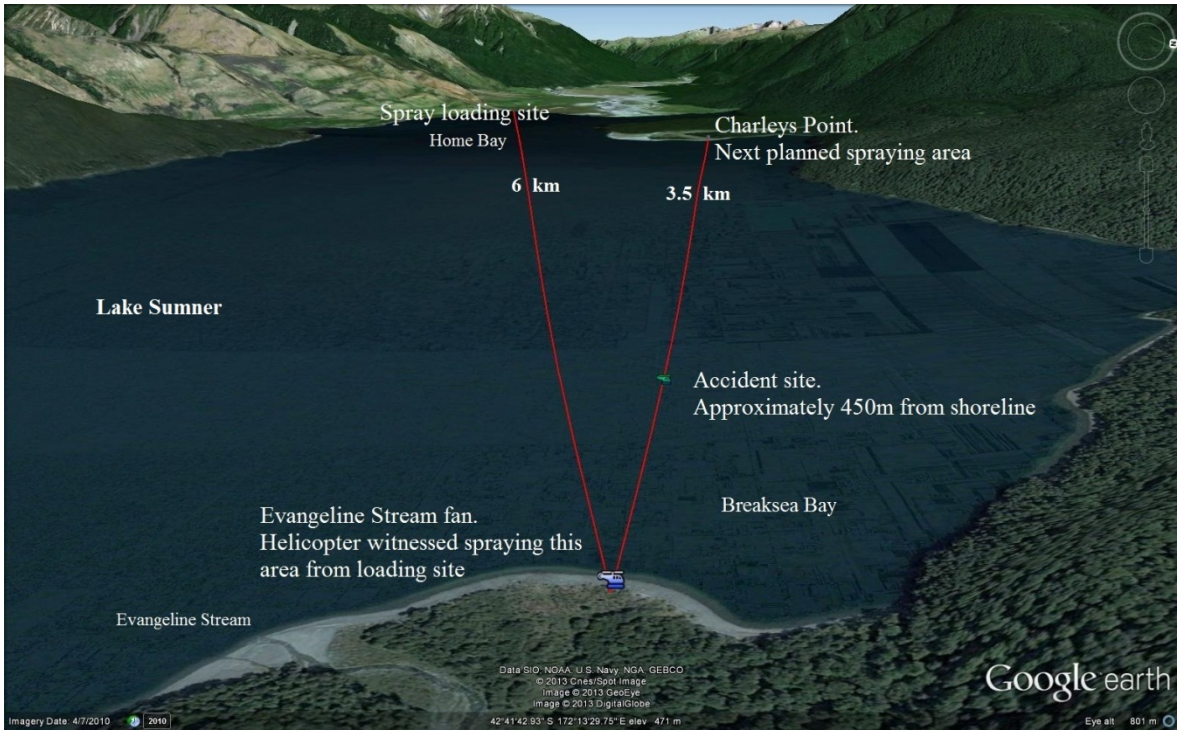

Figure 2.
Last spray area. View toward Charleys Point and loading area.

1.1.8 After the helicopter sound had ceased they looked for the helicopter again but could not see or hear it. Both men were a little concerned at this stage but presumed the pilot had flown back to the eastern end of the lake, perhaps to refuel or carry out more work. The time was noted as 1233 hours. The DOC Ranger

then used his binoculars and carried out a lengthy deliberate scan of the area where the helicopter was last seen. He described the water as being flat and calm with nothing in sight except what he thought were ducks on the water in Breaksea Bay. He also scanned the distant shoreline but did not see anything unusual.

1.1.9 The two men discussed what to do and decided to allow approximately 10 minutes longer for the helicopter to come back, however when it did not they became increasingly concerned. At 1253 hours the DOC Ranger radioed the DOC Regional office in Rangiora to express their concern and arrange for a second helicopter to be sent to them. While they waited they moved to higher ground to get a better vantage point across to Breaksea Bay. The DOC Ranger scanned the area thoroughly again and could still only see what he thought were ducks sitting on the water.

1.1.10 A helicopter from the same company arrived at 1417 hours and picked up both men and a search was commenced for the overdue helicopter. Debris from the helicopter was found floating in the water near where the helicopter was last seen in Breaksea Bay.

1.1.11 The accident occurred in daylight, at approximately 1233 hours on 21 May 2012, in Lake Sumner, at an elevation of 1722 feet, approximate latitude S 42° 41' 40.26", longitude E 172° 13' 34.08".

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Other*
Fatal	1	0	0

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

1.4 Personnel information

1.4.1 The pilot gained his CPL(H) licence on 1 October 2003. His Class 1 Medical Certificate was valid until 6 April 2013.

1.4.2 The pilot had a chemical rating required for helicopter spraying operations which was valid until 27 July 2013.

1.4.3 The pilot's last logbook entry was made on 12 May 2012. The records in his logbook showed that he had flown a total of 3789 hours of which 517 were on Hughes 369D helicopters.

1.4.4 The pilot had flown 55.90 hours in the previous 90 days.

1.5 Aircraft information

1.5.1 Hughes 369D, ZK-HXR, serial number 1170233D, was manufactured in the USA in November 1977; it had accrued a total of approximately 11,910 flying hours at the time of the accident.

1.5.2 The helicopter was issued with a Standard Category Non-Terminating Airworthiness Certificate by the CAA on 17 October 2001.

1.5.3 The most recent maintenance was a scheduled 300 hour inspection of the main rotor blade dampers that was carried out on 24 April 2012.

1.5.4 There were no discrepancies recorded in the helicopters maintenance records nor were any discussed by the pilot during the two reconnaissance flights before the accident.

1.6 Meteorological information

1.6.1 Conditions at the time of the accident were described by the DOC Ranger and the helicopter ground support crewman as being very calm with clear skies. The DOC Ranger added that the lake surface was approximately 90% flat and calm with slight ripples in places (refer Figure 3).

Figure 3.
Photo taken by search helicopter approximately two hours after accident.
White spots are helicopter debris floating on the surface.

1.7 Wreckage and impact information

1.7.1 The New Zealand Police launched a joint search operation with their National Dive Squad and the Royal New Zealand Navy to search for the helicopter wreckage and pilot's body. The RNZN deployed a Remotely Operated Underwater Vehicle (ROV) and their dive team to the site. The ROV was required due the extreme depth of the lake where the helicopter wreckage was believed to be.

1.7.2 The wreckage of ZK-HXR was located approximately 450 metres offshore at a depth of 130 metres, however the pilot's body was not found during the initial search.

1.7.3 Adverse weather then postponed the search for the pilot's body for approximately 15 days. A National Institute of Water and Atmospheric Research (NIWA) operated ROV was subsequently used to continue the search for the pilot's body and assist in his recovery.

1.7.4 Colour video footage of the wreckage was provided to the CAA by the Police from the RNZN and the NIWA operated ROV's while sonar images were provided by the Police National Dive Squad.

1.7.5 The sonar images illustrate that the wreckage was spread over an area of approximately 70 metres by 40 metres, (refer Figure 4).

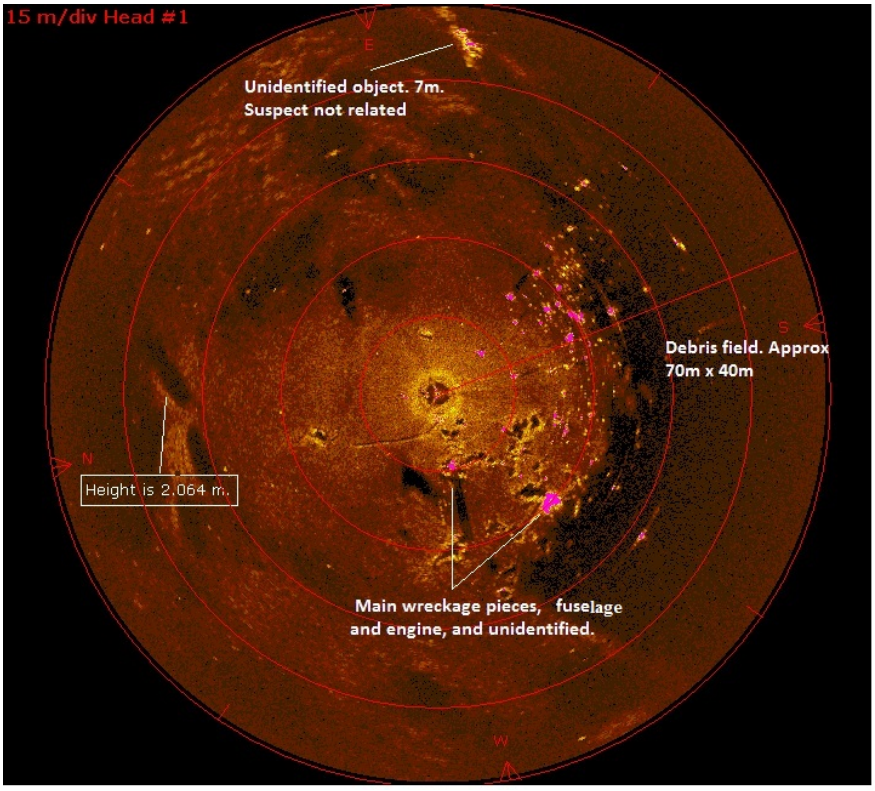

Figure 4.
Police sonar image of debris field (photo courtesy of NZ Police).

1.7.6 The video footage was reviewed by several experts at the CAA. The main fuselage of the helicopter was lying inverted on the lake bed and leaning slightly on its right hand side. It also showed that the front cabin area of the helicopter had suffered a severe upward and rearward disruption.

1.7.7 The footage also showed that both rear undercarriage skid support struts were bent outwards and upwards and there was obvious fuselage impact damage in the region between those support struts. Both front landing undercarriage support struts were broken off their respective front fuselage mounting positions.

1.7.8 The entire tail boom section had separated from the fuselage immediately aft of the engine and was located approximately 20 metres away from the main fuselage section.

1.7.9 The pilot's body was eventually located approximately 15 meters away from the main wreckage after analysis of detailed sonar images.

1.8 Medical and pathological information

1.8.1 The pilot's body was recovered from the lake bed 23 days after the accident. His body showed signs of minor external bruising on his arms and legs and in the vicinity of his waist. His pilot overalls were not torn or damaged.

1.8.2 The post-mortem report identified the cause of death as immersion/drowning. It also revealed no unusual toxicological readings in respect to carbon monoxide or intoxicants and no evidence of controlled substances[3].

1.8.3 There were no indications of any pre-existing medical conditions that could have resulted in incapacitation or have affected the pilot's ability to operate the helicopter.

1.9 Survival aspects

1.9.1 The degree of disruption to the helicopter airframe was characteristic of a high energy accident. The expansive debris field was also indicative of this fact.

1.9.2 The pilot was seen wearing his helmet prior to the last flight. However, it could not be determined how it came to be found floating on the lake surface.

1.10 Tests and research

1.10.1 Aviation research studies explain numerous human sensory systems illusions that pilots may experience while flying at various times and in certain conditions. These illusions are all generically categorised as 'Spatial Disorientation' (SD).

1.10.2 Spatial disorientation is explained as a pilot's inability to correctly interpret an aircraft's attitude, altitude or airspeed in relation to the Earth or some other points of reference.

1.10.3 It is one of the most common factors contributing to aviation accidents and incidents and is most likely to be encountered by all pilots during their careers, whether they are professional or non-professional pilots and regardless of their level of experience. Several factors, such as the pilot, the aircraft, operational

[3] Controlled substance refers to any medication prescribed by a Registered Medical Practitioner.

conditions or environmental conditions, can contribute to the risk of experiencing a spatial disorientation event. Often it is identified that a combination of these factors, rather than just a singular event were causal factors.

1.10.4 There are three basic types of spatial disorientation as follows[4]: Type 1. Unrecognised SD. When a pilot is unaware of any disorientation or loss of situational awareness. The pilot, unaware of the problem, continues to fly the aircraft as normal. This is particularly dangerous, as the pilot will not take any appropriate corrective action, since they do not perceive that there is in fact a problem. The fully functioning aircraft is then flown into the ground, with often fatal results.

Type 2. Recognised SD. This is the most common form of disorientation. It occurs when a pilot detects a mental disagreement between his sensory information and his instruments. If he takes timely action he will successfully resolve the issue before it deteriorates further.

Type 3. Incapacitating SD. This is the most extreme type of disorientation stress. A pilot can be fully aware that something is wrong but he is mentally and physically overwhelmed and unable to take the correct action to recover from the situation.

1.10.5 Somatogravic Illusion occurs as a result of acceleration forces which may cause a pilot's non-visual sensory systems to perceive that the aircraft is climbing. The natural reaction to counter this situation is for a pilot to lower the nose of the aircraft to arrest the perceived climb. The result of lowering the nose is that the aircraft will be placed into a descending attitude (refer Figure 5). The opposite effect can also occur during deceleration. If the aircraft is already operating at a low level then there is an increased risk of collision with terrain before the pilot can intervene.

[4] From ATSB report, "An overview of spatial disorientation as a factor in aviation accidents and incidents".

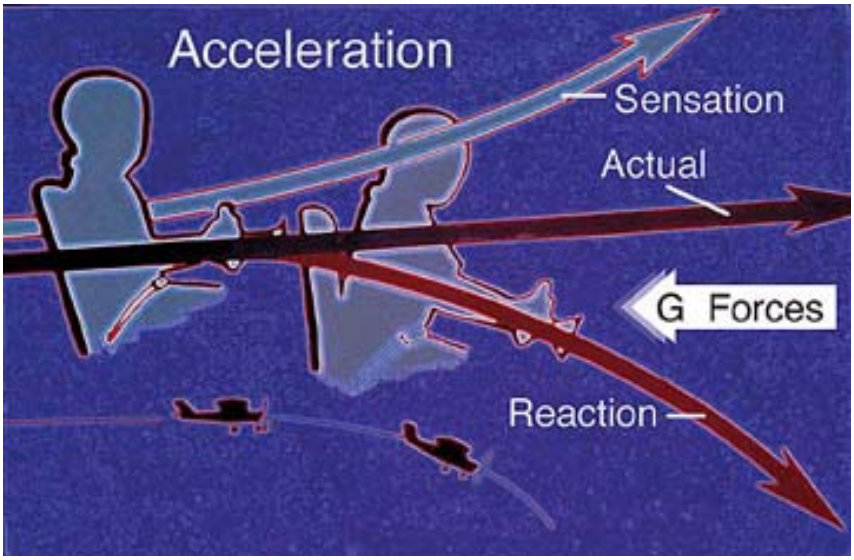

Figure 5.
Illustration of effects of Somatogravic Illusion - acceleration.

1.10.6 The human visual system can also suffer from height perception illusion which occurs during flight over flat terrain where there are few visual cues. In these situations a pilot may experience a false sense of height above the particular surface which may result in controlled flight into terrain.

1.10.7 The CAA prescribes the requirements for pilot qualifications and standards for theory examinations and practical flight tests. The subject of Human Factors (HF) was first introduced in the PPL and CPL exam syllabuses in 1998. The subject of Spatial Disorientation is included as part of the HF syllabus.

1.10.8 A further expansion of the CPL HF syllabus occurred in August 2000 and included the following topic specifically for helicopter pilots; 'Awareness that special perception problems exist in helicopter operations, water flying, and agricultural operations'.

1.11 Additional information

1.11.1 Further information about spatial disorientation can be read in a publication by the Australian Transport Safety Bureau titled, 'An overview of spatial disorientation as a factor in aviation accidents and incidents'. This report is available from the following web link. www.atsb.gov.au/publications/2007/b20070063.aspx

2. Analysis

2.1 The helicopter was observed operating at low level over the lake. The wreckage was located in a position where it was likely to have been flying directly across the lake to its next spraying site, approximately 3.5 km away.

2.2 Evidence found during the investigation, such as the large debris field and the degree of disruption to the cabin area of the helicopter, illustrate that the helicopter collided with the lake surface with considerable force and forward speed.

2.3 There was no evidence of any pre-existing maintenance discrepancies, or any discussion of mechanical issues by the pilot prior to the accident flight. While it could not be comprehensively ruled out that the helicopter experienced some form of unknown mechanical defect, the information available to the investigation did not indicate this was a cause.

2.4 The investigation considered the sounds heard by the two witnesses at around the time of the accident. They had reported hearing a banging noise followed by the [normal] sound of the helicopter for a further 5-10 seconds. Rudimentary calculations found that the sounds of the helicopter operating in the Evangeline Stream area would have taken approximately 17 seconds to travel the 6 km to where the DOC Ranger and ground support crewman were positioned. The sequencing of the sounds heard by the witnesses may have been affected by their preoccupation with their tasks in preparing for the next spray load and the effects of echoes from the surrounding terrain.

2.5 It would have been reasonable to have expected a change in the pitch sound from the helicopter if it had experienced a catastrophic mechanical failure. As there was no reported change in the helicopter sound before or after the banging noise was heard, the investigation considered that this noise was more likely the sound of the helicopter striking the surface of the lake during the accident.

2.6 Conditions on the lake were very calm and the lake surface was mostly still and mirror like. A lack of visual clues while accelerating over the surface may also have contributed to the pilot not recognising the height of the helicopter above the water.

2.7 The investigation found that it was most likely that the pilot probably experienced some form of spatial disorientation in respect to elements of somatogravic illusion and height perception illusion. This resulted in him inadvertently flying the helicopter along a shallow descending flight path.

2.8 These phenomenon have previously resulted in numerous cases worldwide of controlled flight into water and flat terrain, and it is conceivable that this occurred in this accident.

2.9 Due to the remote location of the lake and its depth the helicopter wreckage was not recovered.

3. Conclusions

3.1 The pilot was appropriately licensed, experienced and fit to carry out the flight.

3.2 The conditions at the time were ideal for aerial spraying operations.

3.3 The calm lake surface conditions and nature of the flight at the time were conducive to certain spatial disorientation illusions.

3.4 The wreckage of the helicopter was not recovered. While it could not be comprehensively ruled out that the helicopter experienced some form of unknown mechanical defect, the information available to the investigation did not indicate this as a probable cause.

3.5 The probable cause of the accident was controlled flight into terrain caused by the effects of spatial disorientation.

3.6 The accident was not survivable.

4. Safety actions

4.1 It is proposed that the CAA Safety Promotion Unit consider updating previous articles on spatial disorientation to include special mention of the specific potential illusions that exist when pilots are required to operate an aircraft at low level over indistinct surfaces such as flat terrain or in this case a still lake surface.

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