

Frederikssund Politi



AUV Search in Arresø

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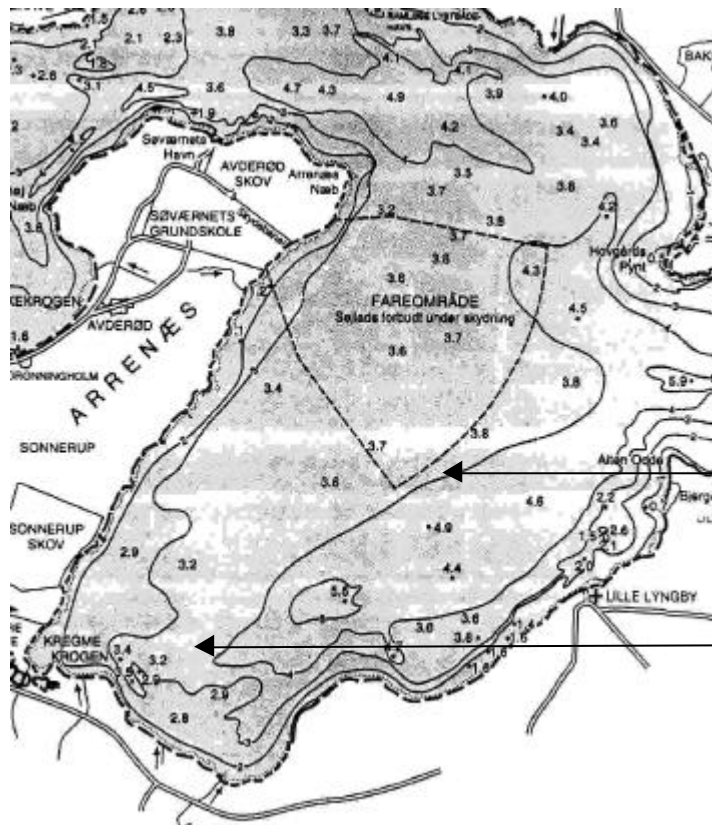
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1. Introduction

This report describes a search & rescue operation in Arresø, a 40 km² Danish shallow water lake (5 m water depth). The target was a helicopter with 3 man onboard that downed in the lake in October 2000. The search was carried out for the Danish police authorities at Frederikssund.

The survey was carried out using the Maridan M-150 Autonomous Underwater Vehicle equipped with a Tritech 675 kHz side scan sonar (ref. 4).



The helicopter was found in the centre of the lake (see Annex 1).

The survey started in the southern part of the lake

Figure 1: Survey area

2. Operational setup

The survey was carried out from the Naval Training facility at Auderød, using one of their 9-meter Launches as support vessel for AUV operations. Onboard equipment includes GPS and 2 PCs for operator control and Side scan viewing. Mobilisation time including transport of AUV to location: 2 hours.

The Naval Training facility provided a truck for launch, recovery and transportation as well as shelter for overnight charging of AUV batteries.



Raised mast with
GPS, Wireless
Ethernet and Data
Radio antennas

Figure 3: Maridan M-150 Autonomous Underwater Vehicle

Navigation was performed using the doppler-inertial navigation system (MARPOS, ref 3).

While at the surface the AUV raised its GPS-antenna to initialise the internal navigation system MARPOS and performed accurate apriori calibration of the sensors. Thereafter MARPOS was used as a stand-alone navigation system.



DGPS Antenna.

Operator PC.

PC for Sidescan
sonar display.

Figure 4: Support vessel for AUV operations

3. Fieldwork

The fieldwork was carried out in 11 days between 17th October and 1st November 2000.

The survey lines were programmed on the operator PC and transmitted to the AUV. After each line the AUV surfaced for transmission of sidescan sonar data (3 minutes for transmission of data from 1 km survey line) and a new survey plan was sent to the AUV. Thereby the operator was able to view the survey data in nearly real time: While the AUV made a line the operator viewed the previous line.

Date	Brief outline of events	Area covered, (km ²)
17.10.00	Mobilise from Maridan's office in Hørsholm. Meeting at Frederikssund Police. Mobilise AUV to Naval Training facility at Auderød. The survey was started in the southern end of the lake.	1.2
18.10.00	AUV survey continued	1.3
19.10.00	AUV survey continued	2.3
20.10.00	No survey (overnight batteries charging failed).	
21.10.00	AUV survey continued	1.7
22.10.00	AUV survey continued	0.9
23.10.00	Exchange of batteries, no survey.	
24.10.00	AUV survey continued	1.7
25.10.00	Target located	1.0
26.10.00	Diver verification of helicopter	
27.10.00	Helicopter recovered	
01.11.00	Final survey of target area in cooperation with Reson A/S	1.0

The target was located after 7 days at sea.

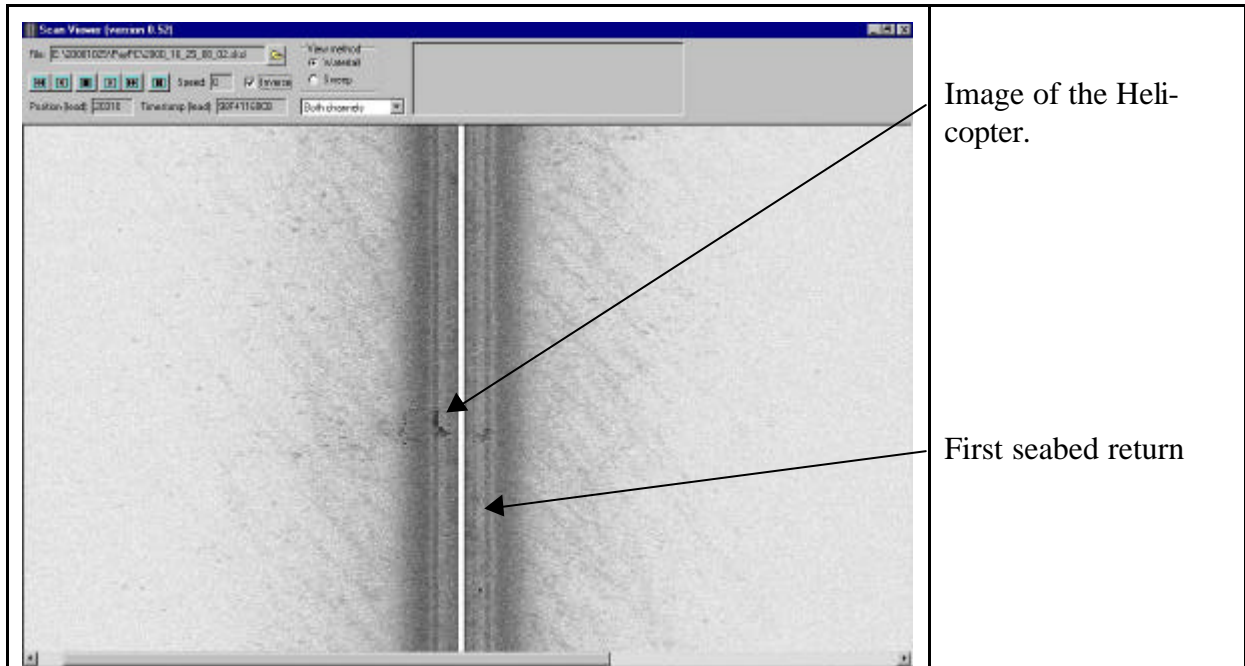


Figure 5: Sidescan sonar image showing the target

Figure 5 shows the sidescan sonar image of the target. The co-ordinates were delivered to the police who confirmed the result by divers next morning: The helicopter was found!

The main results are therefore:

As-found position of the helicopter: 55° 57.771' N, 12° 06.895' E (WGS84)

Total area surveyed by Maridan A/S: 10.1 km².

Total area surveyed by Søværnets Minørkorps: 3.1 km².

See Appendix 1 and 2 for a chart of the search area.

The Sidescan Sonar image of the helicopter does not show very much on the record. This is due to the fact that the AUV passed right over the target. The waterdepth in the area was approximately 4 meters and it can be seen that the target is protruding 1.5m over the seabed.

While attempting to survey the target area 26.10, a wrong survey plan was transmitted that caused the AUV to dive and follow a straight line. The AUV was found next morning at the shore where it during the night had attempted to enter the beach!



Figure 6: Recovery of the helicopter

The helicopter was recovered 27.10. (Figure 6) but the dead bodies were not inside. A final survey of the target area was carried out using the sidescan sonar in high-resolution mode. No targets were located by this survey. Few weeks later the police found the three bodies at the shore.

A total of 11.1 km² was covered during the 8 days at sea (average 1.4 km²/day).

4. Survey technology

A Sidescan sonar system works as an ultrasonic scanner. Well defined acoustic pings are frequently transmitted from two transducers mounted on each side of the AUV. The signals reflected from the seabed provides information on signal strength and travel time. This information is used to generate an acoustic map of the seabed (Figure 7).

Objects on the seabed will reflect the acoustic energy to the transducer. The strength of the reflected signals indicates the hardness of the objects. The distance to the object can be determined from the travel time and the speed of sound in water (approx 1500 m/s). As the transducer proceeds through the water, repeated regular transmissions generates a continuous image (sonograph) of the covered area. The image is display on computer screen (waterfall) during the survey.

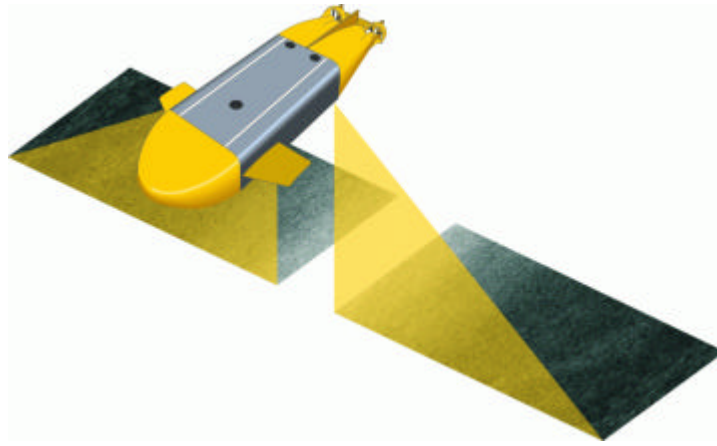


Figure 7: Sidescan sonar, principle of operation

The Side Scan Sonar mounted on the M-150 AUV is a Tritech 675 KHz with the following specifications:

Model ST390-675

Frequency of Operation: 675kHz.

Beam Width, Standard 0.45° to -3dB point

Beam Height 50° to -3dB point

The maximum obtainable range in the shallow lake, was 55 metres either side, whereby a 100m swath was covered with the minimal overlap.

The AUV was programmed to travel in a ‘lawnmover pattern’ with a linespacing of 100m (Figure 8). Typical length of the lines was 1-2 kilometers.

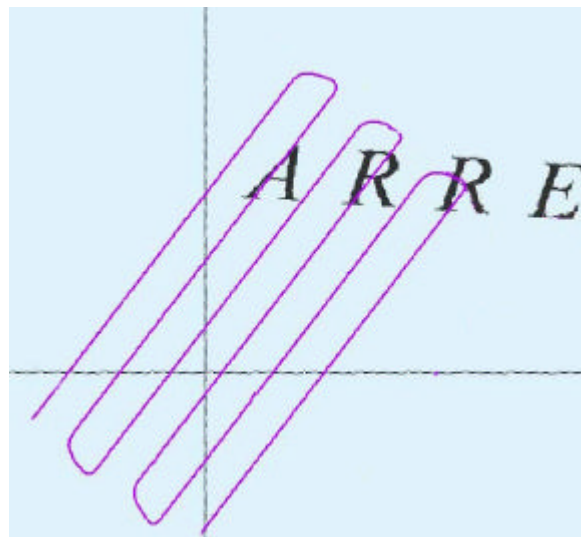


Figure 8: "Lawnmover" pattern, 100 m line spacing

5. Summary

A search operation was carried out for the Danish Police in October 2000 in Arresø, a shallow water lake in Denmark. The purpose of the search was to find a helicopter that has downed in the lake.

The Maridan M-150 Autonomous Underwater Vehicle equipped with a sidescan sonar was used to locate the target. After few hours mobilisation the search started in the Southern part of the lake. After 7 days search the helicopter was found in the centre of the 41 km² lake.

The successful Arresø survey was the first search operation carried out by an AUV. After the survey the Chief Police Inspector Kaj Knudsen stated that search had not been possible in the shallow water low visibility lake without using an AUV.

6. References

1. Aage C, Department of Naval Architecture and Offshore Engineering, Technical University of Denmark, Larsen M B, Department of Automation, Technical University of Denmark, "Manoeuvring simulations and trials of a flatfish type AUV", OMAE'97, Vol. IB, Tokyo July 1997.
2. Bjerrum A, Pind J, "Autonomous Survey Offshore Namibia", AUV Workshop PING99 workshop, Copenhagen 1999
3. Bjerrum A, Larsen M B, Symonds G, "MARPOS® Doppler-Inertial positioning system", Hydrofest, Society of Underwater Technology, Aberdeen, April 1999.
4. Bjerrum A "AUVs are proven technology", Offshore Technology Conference, Houston 2000.

These and other papers can be found at <http://www.maridan.dk/>

Appendix 1

Search & Rescue Operations in Arresø As-Found Position

Appendix 2

Search & Rescue Operations in Arresø As-Found Position And Areas surveyed