

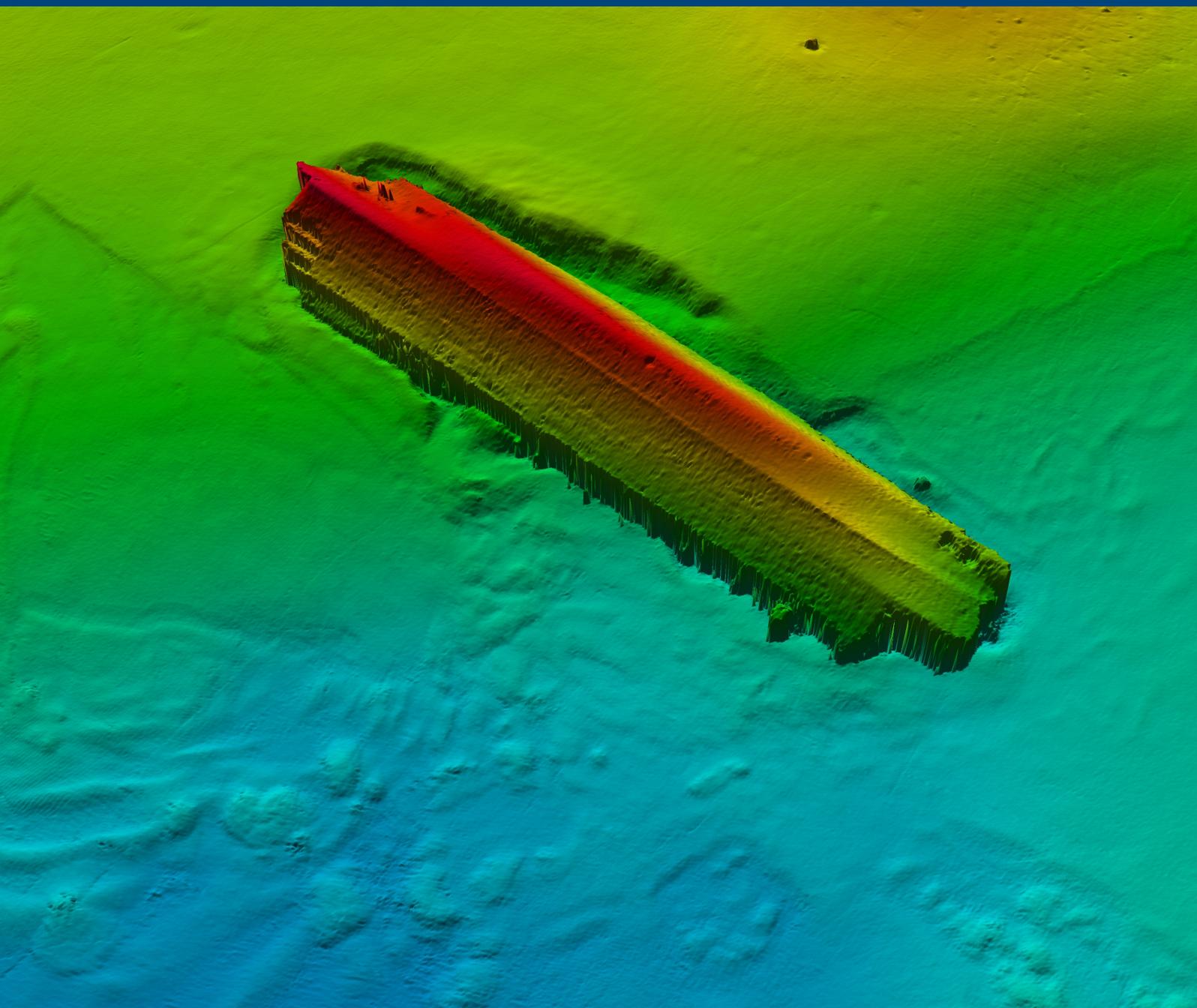
## *EL21-Estonia*

Report of the MS *Estonia* shipwreck site survey with RV *Electra*

### *Appendix 1: Expedition daily notes*

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## Introduction

### **Survey Day 1: Friday July 9**

EK80 survey started 22:37 UTC. Ship time was moved to Estonia time, UTC +3. Survey started without calibration, which we intend to do after the surveys. The EK80 survey followed every second planned line for the sub-bottom profiling grid, except for the N-S lines crossing MS *Estonia*, where every sub-bottom line was followed. ADCP data were captured at the same time. There are generally low current speeds in the area. Three CTDs were acquired during the EK80 survey. Two distinct thermo/halo- clines are seen in the CTD profiles, the upper beginning at about 20-22 m and the lower at about 60 m. There is a clear drop in oxygen from approximately 70 m, and it becomes rapidly oxygen free below this level.

EK80 survey ended at 06:18 UTC, July 10, and a drill with *EVA 316* begun, including docking of the two vessels alongside each other to practice bunkering etc. A technician from the internet provider was also to come over in order to setup a radio link between the vessels for internet and data transfer. The internet is critical for the RTK network service.

The internet connection by NoWhereNetworks was setup and worked successfully. We connected to the RTK service, and received corrections successfully. The accuracy dropped to cm accuracy from just above a meter with SBAS only.

The ceremonial on the Estonian vessels took several hours. Before the ceremony a preparation for launching the ADCP was done. The position 21°41.26' E, 59°23.01' N was decided, NE of MS *Estonia*. Water depth was about 83 m.

The multibeam survey begun with taking a Sound Velocity Profile (SVP) (EL21-SVP01) at 14:03 UTC. The first line was acquired at 14:40, but we did have problem with the RTK that dropped out from the Estonian provider. It turned out that their server for some reason did not deliver corrections for a period of time. Once it did, the survey was resumed. We collected lines both in E-W and N-S direction with 400 % overlap. In addition, three lines run diagonally across the ship wreck were run. The weather deteriorated rapidly and wave heights increased far beyond good survey conditions. Electra was not possible to keep at a slow enough survey speed to achieve a sufficient along track resolution of the multibeam bathymetry, the survey was aborted. At 19:01 the ADCP mooring was deployed. It was not a simple operation due to the waves and *EVA316* came up along side us to act as a wave damper. It proved very successful and the ADCP could be deployed. After the ADCP was deployed, *Electra* set course towards Hangö, where we stayed for shelter from the weather.

### **Survey Day 2: Saturday July 10**

We left Hangö anchoring site at about 09:30 Estonian time (06:30 UTC) and reached the survey site at around noon. The sub-bottom profiler had not been working during a test the day before, the computer could not talk with the PU/Echosounder due to the following error reported: "Serial port could not be initiated". Further investigation showed that this was an ethernet to serial converter that malfunctioned. After rebooting the system, including turning of the main power to the Topas PU, the ethernet to serial converter worked again. Sub-bottom profiling was then moved to the next priority. The first line started at 12:20 UTC in calm weather with only a few m/s wind from SW. The planned survey grid was followed, and additional lines were run across the MS *Estonia*. The survey was ended 19:54 UTC, with a few lines left to do, in order to go to shelter in Kärddla as the wind was picking up. Before leaving, the ADCP site was passed and it was checked with the multibeam if the moored ADCP was pinging, and it appeared to do so. Transit to Kärddla started 20:40 UTC.

**Survey Day 3: Sunday July 11**

In Kärddla harbor. We worked on setting up a second side-scan system (Klein 4900) to be able to use with the small sonar winch since the big Klein 5000 towfish is too big for this winch. It took the entire day to make the system work due to various configuration issues. By the evening, the system worked, the last issue was the navigation had not come in. We found that this was due to the baud rate, which was not read from the setting in the configuration file, as it had to be updated also on the fish side. After setting it to 19200 (the fish setting) navigation data streamed in.

*Electra* left the port of Kärddla 19:30 Estonian time to go out to *EVA 316* where we were going to transfer our waste water over to them. Brian Abbott had arrived and went with us out to meet *EVA 316*. We continued to the survey area, and could begin completing the sub-bottom survey already in the evening at about 22:53 UTC. These lines were completed 23:56 UTC, and we begun with CTD/SVP/Camera sites to check visibility around the wreck.

**Survey Day 3: Monday July 12**

Visibility inspections were made at three locations around the wreck (CTD\_5,6 and 7). The visibility appeared to be at least three meters. Following these stations, the side-scan survey begun. We ended up using the large Klein 5000 system. Launching of the fish went smooth, 120 m cable was paid out. The signal cable was clamped on to the tow wire at regular intervals using zip locks. With a ship speed of 3-3.5 knots we could get the tow fish to depths deeper than 50 m, however, not deeper than 60 m. Since the signal cable had to be fixed, we could not hoist up and down the tow fish. The starboard channel of the side-scan displayed unfocused data. For this reason, we ran the lines to ensure that a mosaic could be compiled using only the port channel. However, lowering the gain on the raw data logging fixed this problem, and after some lines both channels worked fine. The side-scan lines along *Estonia* suffer from many side echoes creating artefacts. Other areas of the survey site were very well portrayed, and we could see for example where bedrock was outcropping. Multibeam data were acquired along with the side-scan. Since we did run every second line in the survey plan designed for the overview multibeam, we could save considerably amount of time. The side-scan survey was completed at 13:58 UTC. Observers were exchanged between *EVA 316* and RV *Electra*. After this was completed, we continued the overview multibeam survey by taking a sound velocity profile and thereafter filling in with additional multibeam lines in between the side-scan survey tracks. Some more CTDs/SVPs were acquired throughout the survey. The RTK dropped out occasionally during the side-scan survey, but was mainly stable. The service from FINNPOS was used since we got new login information and it proved to be more stable than the Estonian provider in the survey area. The overview multibeam survey was completed 20:50 UTC.

At 21:30 UTC a new detailed survey of the shipwreck commenced. This time, the weather was perfect with very calm sea, which permitted slow survey speed, occasionally as low as 1.5 knots. The beam angle was reduced to 25° and the sonar was set to equiangular mode. 8 N-S, 6 E-W, and 4 diagonal lines over the ship were acquired. Some of the lines away from the wreck were ran with a wider beam angle to reach in and collect depths close to the interface between the wreck and the seafloor.

### **Survey Day 4: Tuesday July 13**

The detailed multibeam survey was successfully completed at 01:39 UTC. At 01:50 UTC, an in-fill of an additional EK 80 midwater sonar profile across MS *Estonia* was carried out since data inspection of the previously collected EK 80 profiles showed a data gap in one profile over the wreck. The gap was successfully filled.

A break in survey operations was made from 02:00 UTC as we had to re-shuffle the watch shifts to do the sediment coring the following night. At about 13:00 UTC the survey operations were resumed by beginning inspections of objects identified in the multibeam or side-scan data. A GoPro camera mounted on the CTD frame was lower over selected targets. Several metal frame constructions placed on the seafloor were identified among the targets. CTD profiles were acquired at the camera stations.

Coring operations begun 18:40 UTC (21:40 Estonian time). Sites for piston cores had been identified using the sub-bottom profiles and multibeam data. The objectives for the coring were:

1. Determine the geology of the acoustic units identified in the sub-bottom profiles (piston core).
2. Acquire a sediment core from the type of sediments which have been mass wasted east and west of the wreck (piston core)
3. Determine the geology of the feature that appears like a buried morain ridge or bedrock underneath MS *Estonia* midship, on the northern side, where the hole in the hull has been identified (piston core)
4. Identify the surface sediments in the survey area (grabber). These will be combined with the multibeam backscatter and side-scan information in order to produce a surface sediment distribution map.

Three piston cores were taken. The first piston core (EL21-Estonia-PC\_01) was collected just up-slope from where the slides occurred and west of the wreck. The corer appeared to fall over, but 205 cm of sediment was acquired. The core was cut into two sections (Sec 1: 81 cm, Sec 2: 124 cm), and it seemed like all of the collected sediments are comprised of medium to coarse grained sand, likely the sand they dumped to stabilize the area around MS *Estonia*. The second piston corer was moved much further to the west of the wreck area in order to capture the clay unit that had mass wasted, which we could not penetrate to at the first site because of the sand. A grab sample was first taken to ensure that we had moved away from the sand. A 545 cm long piston core (EL21-Estonia-PC02) was acquired at this site. This core was cut into 4 sections (Sec1=137.5 cm, Sec2=150 cm, Sec3=126 cm, Sec4=131cm). From inspection of the section ends, the core appears to be comprised of gyttja clay in top and more stiff clay in the bottom of the core. The third, and last, piston core site was located on top of the ridge-like feature identified north of the wreck mid-ship, approximately 18 m north of the hull. Also here, a grab sample was first acquired. This piston core (EL21-Estonia-PC03) retrieved 234 cm of sediments. The core cutter hit a hard object and was damaged.

### **Survey Day 5: Wednesday July 14**

The sampling program continued after piston coring site with collections of several grab samples. At about 03:19 UTC the camera inspection program was resumed. In the morning around 08:00 UTC the boomer program could start by acquisition of profiles in the same survey grid as made for the Topas PS40 sub-bottom profiles. The objective was to acquire information deeper

down in the stratigraphy than reachable with the Topas. During the survey we had an abundance of acoustic disturbance coming and going. We ensured that these were not caused by any of *Electra's* echo sounders. Apparently, the Mesotech surveys onboard *EVA 316* had also suffered from disturbances. The boomer survey was completed at 17:30 UTC as it was time to bunker from *EVA 316* and end the entire survey on our behalf. The last thing done from *Electra* was to retrieve the ADCP.