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3D recording of the site of the Finnish four-masted fore-and-aft schooner that sank in 1941

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INTRODUCTION

The development of 3D technology has made it possible to fully record wreck sites in a relatively short time during fieldwork and it has become the main working tool for maritime archaeologists (see McCarthy *et al*. 2019; Roio 2019). 3D recording of wrecks has become irreplaceable in heritage protection for achieving its objectives by enabling to carry out detailed inventories and assess the condition. 3D recording can be used as a starting point for long-term monitoring and for understanding the natural processes at the site. 3D models make it possible for scientists, who do not perform underwater archaeological research themselves, to still study the sunken sites. Making the underwater cultural heritage visible to a wider audience of people interested in history can be considered equally important. One of the widely used online platforms for displaying 3D models is Sketchfab (https://sketchfab.com/muinsuskaitseamet).

In the summer of 2020, the National Heritage Board of Estonia carried out a 3D recording at the wreck site of Gullkrona. The site was initially filmed and photographed in early spring 2019, shortly after it had been discovered. The wreck of Gullkrona immediately became a very popular diving destination, as it is relatively easily accessible and the depth is suitable for recreational diving. In addition, there is usually quite good visibility at the site – an average of seven metres even in mid-summer. The wreck had been thoroughly filmed prior to extensive diving activities, therefore it is possible to evaluate the changes in the condition of the wreck and the causes behind those changes.

In 2020, the National Heritage Board began the process of placing the wreck of Gullkrona under state protection and it has been scheduled in the National Registry of Cultural Monuments as number A31031.

CONSTRUCTION DATA OF THE SHIP

The four-masted fore-and-aft schooner Gullkrona was built in 1921 in the Dragsfjärd municipality in Finland. The overall length of the ship was 54.88 metres, the moulded length 50.51 metres, the breadth was 10.3 metres and the draft 3.43 metres (Fig. 1). During the time of sinking, the home port was Mariehamn and the ship was owned by Suomi Shipping AB. In terms of its dimensions, Gullkrona was one of the largest wooden vessels built in Finland at that time (Suomen kauppalaivasto 1940, 78–79). In 1940, the average length of wooden motor sailers registered in the Finnish cargo ship registry was 20–30 metres (*ibid*., 74–89).

THE SINKING OF GULLKRONA

In the beginning of January 1941, Gullkrona, with 12 crew members on board began the journey from Rostock to Finland carrying a load of coal. A storm broke out when they reached Gotland, and the ship developed a leak. In addition, Gullkrona had a small collision with the Swedish passenger steamer Fårösund, as a result of which one of the two lifeboats on board was broken. The consequences of the collision seemed trivial, and it was decided to continue the route to Finland through Estonian coastal waters. The storm winds picked up again and the crew resolved to find shelter at the coast of Hiiumaa. In the evening of 10 January, they dropped the anchor on the border of drift ice into the depth of approximately 17 metres, located 6 nautical miles off the coast of Sõru in Hiiumaa. Soon, the main body filled halfway with water and part of the crew set on the way to get help from the coast. The skilled assistance from the locals helped to rescue the rest of the crew members from the schooner, even though they needed to wait several hours to receive clearance from the border guard (Kõmmus *et al*. 2015, 61–63). In 1941, Hiiumaa was under the control of the Soviet Army and all the rescued Finns were arrested as potential spies. Approximately three weeks and countless interrogations later, the prisoners were handed over at the Finnish border.

Fig. 1. *Gullkrona most likely in the Port of Turku.*
Jn 1. *Gullkrona tõenäoliselt Turu sadamas.*
Photo / Foto: Atelier Auer Åbo Finland, Maritime Museum of Finland,
(SMK90060:27, https://www.finna.fi/Record/musketti.M012:SMK90060:27.)

In 1975, the Finnish Water Rescue Association tracked down the persons who had saved the lives of the Gullkrona crew members and honoured them with a golden Water Rescue medal. Only one of the four men, who had participated in the rescue operations, was still alive at the time (Kõmmus *et al*. 2015, 93). The circumstances of the sinking have been thoroughly analysed and published (Kõmmus *et al*. 2015; Saar 1994).

DISCOVERY AND SURVEY

In spring 1941, the mast-heads had still reached out from the water. The wreck began to break further with the autumn storms and waves brought the masts to the shore of Külaküla village (Saar 1994; Kõmmus 2015). The wreck site of Gullkrona was known to fishermen, but the knowledge became blurrier as years went by and the site was finally confirmed only in 2018.

In 2018, the Estonian Maritime Administration was conducting hydrographic surveys and found a wreck approximately 10 kilometres northwest of Tohvri village at a depth of 17 metres (Fig. 2). The multi-beam sonar revealed the wreck of a sailing ship,

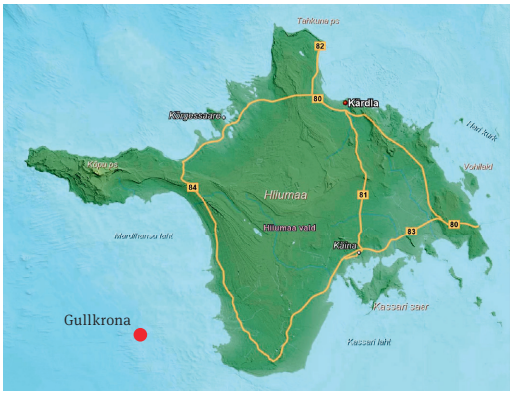

Fig. 2. *Location of the wreck west of Hiiumaa.*
Jn 2. *Vraki asukoht Hiiumaast läänes.*
Map / Kaart: Estonian Land Board/ Maa-amet, Maili Roio

with the length of 52 metres, width 10.5 meters and height 5.28 metres (the highest point of the wreck, which is a broken mast). It was clear relatively soon that a wreck with such remarkable measurements can only be Gullkrona.

In April 2019, the wreck was photographed and filmed by Estonian Navy diver Rasmus Pruul and underwater photographer Egert Kamenik, who were collecting materials for the Gullkrona exhibition planned in Sõru Museum. Photographing and filming in the early spring of 2019 took place in extremely good environmental conditions. The visibility was more than 10 metres, the water was clear and artificial light was not needed. The wreck was filmed from the sides and from the top for the total of 46 minutes. The National Heritage Board used the video footage to create a 3D model. This was the first thorough documentation of the wreck. Already in summer 2019, the wreck site became a relatively popular destination for recreational divers.

In summer 2020, the National Heritage Board compiled a new 3D video recording and created a new 3D model which covered also the loose details in the vicinity of the wreck. Three dives were conducted, each with an average of 35 minutes filming time. There was a lot of floating organic matter and jellyfish in the water, visibility was under 10 metres. In addition to daylight, 2 × 17 000 lm and 1 × 30 000 lm lights were used. Thanks to the fact that the wreck was recorded immediately after it was found, it is possible to assess if, and what kind of impact has human activity had on the wreck site in the course of two years since it was found.

The National Heritage Board filmed the wreck once again in early spring 2021, this time using an underwater robot FIFISH PRO V6 PLUS and without additional artificial lighting, when the visibility at the site was approximately 15 metres.

The materials of all three recordings were used to create 3D models by using the Agisoft Metashape program. The most accurate and undistorted result was achieved with the footage filmed with the underwater robot in 2021 (Fig. 3).

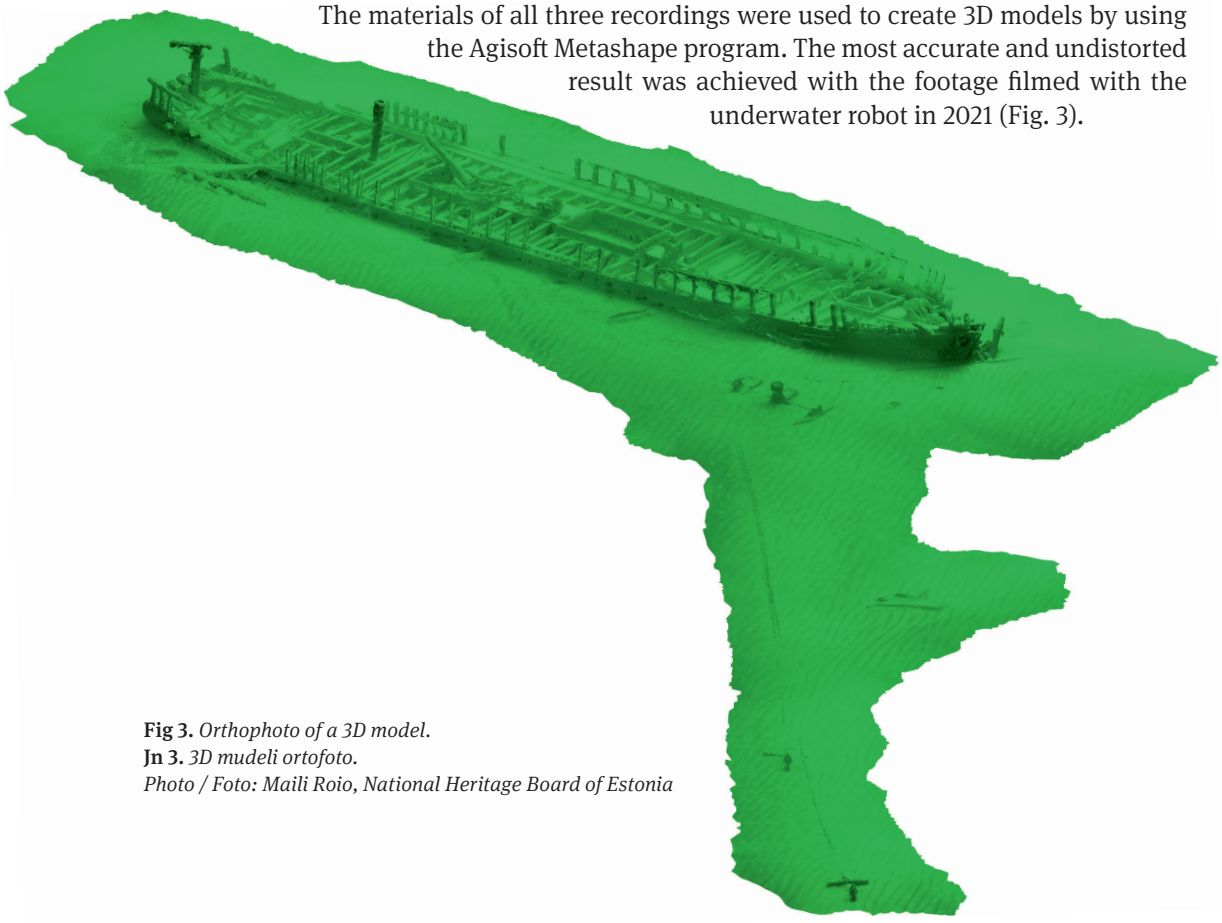

Fig 3. *Orthophoto of a 3D model.*
Jn 3. *3D mudeli ortofoto.*
Photo / Foto: Maili Roio, National Heritage Board of Estonia

CONDITION OF THE WRECK

The wreck is well preserved, despite the fact that Gullkrona sank in relatively shallow water. Preservation has been facilitated as most of the wreck is embedded in the sand and only a small part of it is above the seabed.

The ship has preserved in the extent of the main deck, which has not yet disappeared under the sand. The deck planking has preserved only to a small extent near the haulers at the middle line of the ship. The deck structures that are visible on the historical photo have not preserved. The preserved deck supporting features include deck beams, lodging knees, carlings, and ledges. A large part of the bulwark has also preserved: covering board, bulwark stanchions and the main rail. The bulwark planking has not preserved. One detail from the aft topgallant rail has fallen to the bottom of the sea next to the starboard. The windlass has preserved at the bow and one of the anchors is lying on the port-side. Bollards and the anchor chain are visible near the starboard of the bow. The anchor chain reaches tens of metres away from the wreck. Two anchors that have been laid out in the same line, have been used to anchor on a relatively flat sandy seabed.

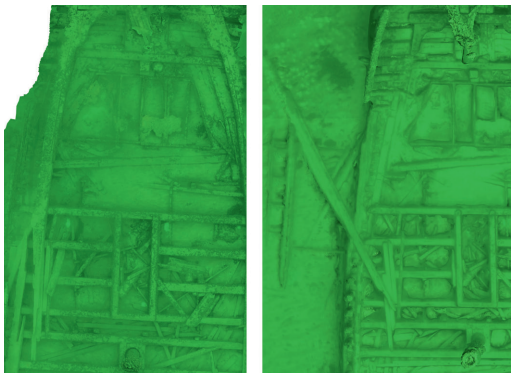

Fig. 4. *Comparison of deck planking in the starboard of the aft in 2019 and 2020.*
Jn 4. *Tekiplangutuse 2019. ja 2020. aastate võrdlus ahtris tüürpoordis.*
Photo / Foto: Egert Kamenik (2019), Maili Roio (2020)

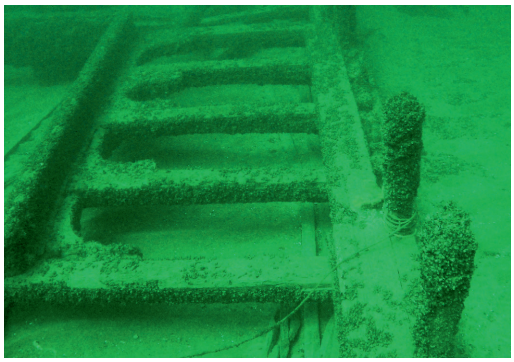

Fig. 5. *Bulwark stanchion in the starboard with a shot line attached to it.*
Jn 5. *Tüürpoordi toptimbri külge seotud laskumisots.*
Photo / Foto: Maili Roio (2020)

Out of the four masts, the spanker and lower mast are still standing upright. The foremast and mainmast have preserved up to the main deck. The location of the mizzenmast is marked by a mast hole. Most likely the lower mast of the mizzenmast has fallen halfway into the cargo hatch. The remains of the rudder gear are towering in the aft and there are many small details inside and around the ship, which originate mostly from the running gear.

Comparison of condition

The main damage to the ship has occurred at the time of sinking and during the first year after sinking. There are few secondary damages and those have occurred only after the wreck was discovered (Fig. 4–5). The ship's bell was found during the filming in early spring 2019. At the time of finding, only a small part of the bell was visible under the sand. The divers decided to clean the bell from the sand and applied for permission from the National Heritage Board to retrieve the bell from the seabed and display it at the planned seasonal exhibition in Sõru Museum. The first choice is always to preserve wreck finds and everything belonging to it *in situ* (UNESCO 2001). Retrieving objects is not justified with the purpose of displaying an item at a temporary exhibition or

for complementing museum collections. Therefore, the National Heritage Board denied the request and the ship's bell remained at the location where it was found.

When comparing the recording data, it was possible to observe some damages in the starboard of the aft, where one deck plank has come loose and is now situated with one end of the plank on the deck and the other end on the seabed next to the wreck (Fig. 4). Most likely this has been caused by a diving vessel during anchoring. A line that has been attached to one of the bulwark stanchions at the starboard is also visible (Fig. 5). The line has probably been used as a shot line and at some point the float has been cut loose. There are no other observations and all small details are still in their original location.

CONCLUDING REMARKS

The Baltic Sea as a whole is unique, providing a suitable environment for long-term preservation of wooden shipwrecks. The main damages of the wreck of Gullkrona have occurred after sinking. Even though Gullkrona sank in relatively shallow water, the natural processes and environmental conditions of the Baltic Sea ensure the long term preservation of the wreck. The ship has preserved up to the main deck level, an average of two metres of the ship's hull is visible on the seabed.

The seabed around the wreck is sandy. Since sand is relatively dense and hard, the anchor of a diving vessel has only stopped once it hit the wreck. The damage at the starboard of the aft has most likely been caused by a larger diving vessel anchoring. This type of damage cannot be caused by the use of a shot line.

Placing the wreck under state protection will enable to prevent anchoring at the site. When the wreck is declared a cultural monument, the regulations of the Heritage Conservation Act which address the matter of anchoring at a cultural heritage site and its protection zone will apply – anchoring at the site is not allowed and anchoring at the protection zone of the monument is only allowed when the National Heritage Board has been notified. The National Heritage Board is entitled to refuse the anchoring request, but this is not sufficient to protect the site. It is important to take into account that this is a diving destination that is becoming increasingly popular.

Once the wreck is declared a cultural monument, the Heritage Board can arrange to install a stationary mooring buoy near the site. This has been done in cooperation with the Estonian Maritime Administration for over ten years. On the one hand this is a necessary practice at the popular dive sites for ensuring safety during diving, on the other hand many wrecks of interest are located at open sea, it has been difficult to find the best permanent solutions for installing mooring buoys and there have been many failures. For mitigating risks and taking into account the ice conditions in recent years, the mooring buoys have not been seasonal, but have been in place all year round since 2019. Since there is no heavy traffic in the sea area of the wreck site of Gullkrona and it is not located in open sea, the risks for installing a stationary anchoring buoy should be low.

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1941. AASTAL UPPUNUD SOOME NELJAMASTILISE KAHVELKUUNARI GULLKRONA LEIUKOHA 3D-DOKUMENTATSIOON

Maili Roio

2020. a suvel tegi Muinsuskaitseamet Soome purjelaeva Gullkrona hukukohal allveearheoloogilisi uuringuid. Peale vraki leidmist pildistasid ja filmisid mereväe tuuker Rasmus Pruul ja allveefotograaf Egert Kamenik leiukohta Sõru muuseumisse planeeritava Gullkrona näituse tarbeks 2019. a varakevadel. Gullkrona vrakk sai kohe väga populaarseks sukeldumise sihtkohaks, kuna see on suhteliselt kergesti ligipääsetav ja hobisukeldumiseks sobival sügavusel. Pealegi on vraki leiukohas tavapäraselt suhteliselt hea nähtavus, ulatudes ka südasuvel keskmiselt seitsme meetrini. Tänu asjaolule, et vrakki oli põhjalikult filmitud enne aktiivsema sukeldumistegevuse algust, on võimalik hinnata ligi kahe aasta jooksul toimunud seisukorra muutusi ja nende põhjuseid.

Neljamastiline kahvelkuunar Gullkrona ehitati Soomes Dragsfjärdi vallas 1921. aastal. Laeva kogupikkus oli 54,88 m, laius 10,3 m ja süvis 3,43 m (jn 1). Hukkumise ajal oli kodusadamaks Mariehamn ja omanik Suomi Shipping AB. Oma mõõtmete poolest oli Gullkrona üks suuremaid puidust aluseid, mis sel ajal Soomes ehitati. Rostockist kivisöelaadungiga Soome teel olnud Gullkrona hukkus jaanuari alguses 1941 Hiiumaa all. Kõik meeskonna liikmed pääsesid.

Gullkrona vrakk asub Tohvri külast Hiiumaal ligi 10 km loodes 17 m sügavusel (jn 2). Gullkrona on säilinud peateki ulatuses ja vrakk on suures osas liiva sisse mattunud (jn 3). Ehkki Gullkrona uppus suhteliselt madalas vees, tagavad looduslikud protsessid ja keskkonnatingimused vraki pikaajalise säilimise. Peamised purustused tekkisid hukkumise ajal ja sellele järgnenud aastal. Teiseseid kahjustusi on vähe ja need pärinevad vraki leidmise järgsest ajast. Kahe aasta dokumenteerimisandmete võrdlemisel võis täheldada peamisi kahjustusi ahtris tüürpoordis, kus üks tekiplank on oma algsest kohast lahti tulnud ja paikneb nüüd otsapidi teki peal ja vraki kõrval merepõhjas (jn 4). Arvatavasti tekkisid need sukeldumisaluse ankurdamise tõttu. Kuna tegemist on populaarse sukeldumiskohaga, tuleb edasiste ankurdamisvigastuste ennetamiseks kaaluda statsionaarse ankrupoi paigaldamist.