

Maritime Archaeological Society  
of Finland



## Report on Analysis of Failed Cannons on the Kronprins Gustav Adolf Wreck site



Maritime Archaeological Society of Finland report for the Finnish Heritage Agency's research permit **MV/00971/2025** regarding failed cannons on the *Kronprins Gustav Adolf* wrecksite near Suomenlinna, Finland, MVID#1291. Methods included intrusive encrustation removal.

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# Failed Cannons Intrusive Survey Report

By James Fowler and Markku Luoto

## Project Background

Permission was granted by the Finnish Heritage Agency in the Spring of 2025 to examine three possible examples of exploded naval guns located on the *Kronprins Gustav Adolf* wreck site off Suomenlinna, Finland. The purpose of the study was to locate and record any exploded or otherwise damaged naval guns on the *Kronprins Gustav Adolf* wreck in support of James Fowler's master's thesis research at East Carolina University.

Fowler's thesis analyzes an attempt to utilize engineering Computer Aided Design (CAD) software to conduct Finite Element Analysis (FEA) on models of 17th century, 18th century and 19th century naval guns in order to simulate how guns fail. James Fowler collaborated with the Maritime Archaeological Society of Finland (MAS) and the Finnish Heritage Agency to access the *Kronprins Gustav Adolf* wreck to inspect exploded guns located thereon, permit ref MV/00791/2025. *Kronprins Gustav Adolf* was a 62 gun third-rate ship of the line which sank in action during the Russo-Swedish War of 1788 (Anderson 1910:246<sup>i</sup>; Tredrea and Sozaev 2010:470<sup>ii</sup>; Roio 2022:187–189<sup>iii</sup>; Tikkanen 2000:32-68<sup>iv</sup>).

Additionally, Dr. Eric Oakley was onboard in an advisory and observational role, to view Maritime Archaeology Society of Finland operations in preparation for the East Carolina University 2025 Fall Field School.

## [Kronprins Gustav Adolf \(Helsinki\) MVID#1291](#)

The *Kronprins Gustav Adolf* shipwreck is comprised of mostly oak timbers, with the wreck site spanning 40m long and containing several dozen cannons. The wreck is most likely the Swedish ship of the line *Kronprins Gustav Adolf*, which was destroyed and sank on the nearby Gustav Adolf Shoal in 1788 during the war between Gustav III and Catherine II of Russia. The wreck site is Europe's first shipwreck park.





## Location (WGS84) and date of last inspection

Lat: 60° 3.0399' N, Lon: 24° 55.5701' E // June 3, 2024

## Depth & length & direction

approx. 20 m, approx. 40 m, direction of sound approx. 70°/250°

## Research team and rapporteur

James Fowler and Markku Luoto



Figure 1: The location of the Kronprins Gustav Adolf wreck site. (MAS 2026)





## Methodology

A Finnish Heritage Agency permit was acquired by MAS and James Fowler to conduct research on the wreck. The team of researchers included Markku Luoto, James Fowler, Dr. Minna Koivikko, Dr. Eric Oakley, along with a variety of support personnel including a dive safety officer. Several days were available to conduct the research if poor weather was encountered, however the research was completed on the first available day. The wreck was located and dives were conducted on 14 May 2025, and the research vessel utilized was the DSV Stella captained by Vesa Saarinen from MAS.

## Diving

The objective was to complete three dives: the first dive to scout the wreck and secure the mooring ball, the second dive to conduct photogrammetry, and the third dive to conduct encrustation removal. The second dive would allow Fowler to closely inspect the submerged cannons and determine a priority for removing encrustation on dive three. Detailed study of the photogrammetric site map of the *Kronprins Gustav Adolf* shipwreck allowed the dive teams to quickly orient themselves on the wreck and find the cannons of interest. The water temperature was recorded at a minimum of 3.9 degrees Celsius, thus drysuits were utilized. A maximum depth of 21.64 meters was recorded. Teemu Kerola, the dive safety officer, ensured that all mandatory surface intervals were adhered to and that safe diving practices were followed.

Additionally, full facemasks and communication systems were implemented to aid in safety. Discussion utilizing diving communication systems can be difficult to interpret during the best conditions, and communications between dive teams during this operation consisted of an American individual (Fowler) and several Finnish individuals (Luoto, Koivikko). The American/Finnish English accent barrier made some communication difficult; however, this effect was quickly mitigated by the inclusion of American and Finnish individuals onboard *Stella* who could listen to the diver communications and help clear up any misunderstandings due to language/accents. This significantly helped simplify diving operations and allowed communication to be conducted with relative ease and can be recommended for future operations where accent barriers may be in play.

## Photogrammetry

Photogrammetric data was recorded using 4k and FHD stereo video utilizing a dual-camera photogrammetry rig. Lighting was provided by two flood lights mounted on the photogrammetry rig. Additional lighting was provided by accompanying divers utilizing their personal dive lights. A maximum recording distance of 2 meters from the artifacts was adhered to when possible, and a spiralling pattern was used to capture data from every angle.





## Encrustation Removal

Encrustation was removed utilizing a metal crowbar, implemented to lightly tap the encrustation layer. This action would loosen the encrustation. After taping, the crowbar was utilized as "a rolling pin" to roll across the face of the encrustation, to allow water to enter the encrustation matrix and loosen the bond. That would allow the encrustation to flake off gradually. This operation was conducted repeatedly, slowly removing layers until the original metal surface was uncovered. After every layer of encrustation was removed, detailed 4k photogrammetry was conducted on the encrusted area before the next layer of encrustation was removed. This ensured that if any details were mistakenly destroyed during the encrustation removal, digital reconstruction of the artifact would be possible. Fortunately, no accidental damage was imparted to the cannons.

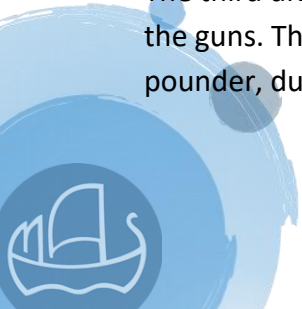
## Fieldwork

The weather was acceptable, with partially cloudy skies and 5-10 knot winds from the east. Light rain showers were present throughout the day; however, these conditions did not impede diving operations. Air temperatures were recorded between 10- and 18-degrees C. Little current was present on the site, and the sea state was calm. Surface water temperature was recorded at 6.66 degrees C, and bottom temperature was recorded at 3.88 degrees C. Visibility was good, with a minimum distance of approximately 5 meters.

The first dive team was dispatched to determine if the visibility was conducive to completing the objectives of the research, as well as to locate the mooring line and attach the mooring ball to the line. This dive team consisted of Markku Luoto and Georg Ahti, and the dive took approximately 15 minutes.

The second dive was conducted to complete photogrammetry of the three damaged guns located on the site map. This dive team consisted of Dr. Minna Koivikko and James Fowler, Koivikko acting as dive leader and guide, and Fowler operating the photogrammetry equipment. The total dive time was 38 minutes reaching a maximum depth of 21.64 meters. Photogrammetric images were taken of two of the exploded guns, however the suspected third exploded gun was determined to likely not be damaged at all, rather it was determined to more likely represent an intact example of a carronade or short-barreled 24- or 32-pounder. Because this weapon was determined to be outside the scope of the study, no new photogrammetry was taken of this weapon. Photogrammetry of the remaining two weapons was then recorded.

The third dive was conducted after an appropriate surface interval to remove encrustation from one of the guns. The gun chosen for encrustation removal was the larger of the two weapons, the 32-pounder, due to the accessible right trunnion and likelihood of success. This dive was led by Markku





Luoto, with James Fowler and Georg Ahti. Fowler and Luoto took turns delicately removing encrustation while the other provided directed light on the cannon trunnion utilizing dive lights. Georg Ahti was solely responsible for conducting photogrammetry on the trunnion in short increments, to record each layer of encrustation removed. After approximately 2 centimeters of encrustation was removed, the right trunnion's makers mark became apparent. The letter "E", or possibly interpreted as "M", was uncovered, and documented using photogrammetry. Upon uncovering this data, the dive was terminated and the team returned to the surface. The total dive time was 48 minutes and 15 seconds, and the maximum depth was recorded as 21.64 meters.

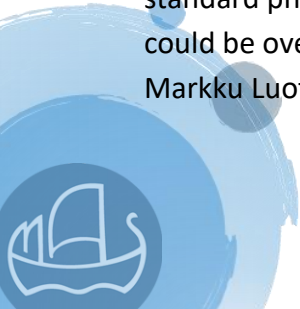
The forward half of the 32-pounder can be visualized in Figure 2. The right trunnion with encrustation removed and the letter highlighted in yellow can be seen in Figure 3.



*Figure 2: The forward half of the 32-pounder, photogrammetric model by MAS 2025. "1" indicates the location of the exposed trunnion.*

The photogrammetric recording was conducted within 2 meters of the cannons, in accordance with standard photogrammetry techniques. Scale bars were not needed, because the new photogrammetry could be overlaid onto master sitemap of the wreck to achieve a scale of acceptable accuracy.

Markku Luoto made a 3D model of both cannons on the Maritime Archaeological Society's modeling





server and later optimized and annotated the models in Sketchfab. All source material and results can be found in the "masdownload" link: [https://masdownload.jej.fi/kohteet/1291\\_Gustav\\_Adolf/](https://masdownload.jej.fi/kohteet/1291_Gustav_Adolf/)



*Figure 3: The letter "E" on the trunnion, denoted in yellow, 14 May 2025. Image by Markku Luoto, courtesy of the Maritime Archaeological Society of Finland.*

## Results

Included below is a review of the two cannons recorded, as well as some preliminary results of the research. Additionally, the 3D models of the guns are shown below, and the utilization of the results are described.

### Item description

The cannons are located on the wreck at a depth of approximately 21 meters. The overall size of the wreck is approximately 50 by 10 meters, and is oriented roughly east–west, with the bow facing east. The cannons of interest are located amidships on the port side. The first cannon, identified as a Swedish Finbanker 32–pounder is approximately 2 meters in length and around 50 centimeters wide. This can be viewed in

Figure 4. The letter "E", or possibly interpreted as "M", was uncovered underneath the encrustation.

[www.mas.fi](http://www.mas.fi) | [mas@mas.fi](mailto:mas@mas.fi) | [Signal-ryhmä](#)  
[www.facebook.com/meriarkeologia](https://www.facebook.com/meriarkeologia)

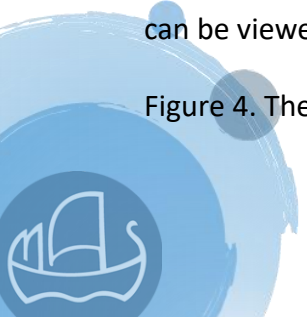




Figure 4: A photogrammetric model (by MAS) of the broken 32–pounder on which decrusting was performed, denoted by red boxes in “site map” and in “close up”.

The weapon was heavily encrusted and broken in half aft of the trunnions, but in good condition in the areas where the concretions were removed. Archaeological work was focused on the right trunnion. No further removal of encrustation was conducted on the left trunnion or aft section of the cannon due to time constraints and bottom time constraints, so no markings were recorded. The second gun, likely a 24–pounder, also had photogrammetric data collected on it, however no encrustation was removed. This weapon can be visualized in Figure 5. Further analysis and encrustation removal is recommended on this gun.



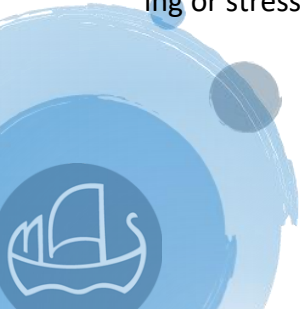


Figure 5: A photogrammetric model (by MAS) of Cannon SW-02, broken in half.

### Preliminary interpretation

This study is focused on interpreting the exploded guns onboard the *Kronprins Gustav Adolf*. These guns are both larger caliber pieces and also both failed aft of the trunnions. Several preliminary trends are notable. *Kronprins Gustav Adolf* sank in 1788 in the initial months of the Russo-Swedish War (Anderson 1910:246). The 32-pounders located on the ship, numbering twenty-six in total, were fielded only during wartime as records indicate that the Swedish Navy replaced the 32-pounders with lighter and cheaper 24-pounders during peacetime operations (Tredrea and Sozaev 2010:470). If accurate, and considering that the ship sank early in the conflict, it is unlikely that the 32-pounders present on the wreck saw much usage at all previous to the conflict. They likely sat in ordinary for many years before being quickly fielded with the Swedish fleet.

Cannons subjected to long tenures of low maintenance are especially prone to honeycombing and extensive bore corrosion. These effects could have been present within the bore to weaken the interior structure of the guns, unless they were routinely inspected and cleaned. This might have resulted in the failure observed in the 32-pounder. Additionally, if the weapons were not fielded during peacetime training, it is unlikely that the gun crews of *Kronprins Gustaf Adolf* had substantial experience calculating the correct powder loads to utilize when firing the larger guns, and mistakes due to poor training or stress may have been more prevalent. This may have also resulted in a gun failure.





Alternatively, either gun may have burst during the sinking event. If the guns reached a very high temperature during the shipboard fire, and then were rapidly quenched during the sinking, thermal shock could have fractured one or both of the guns in half. It is unlikely that either gun was damaged by enemy forces during the capture of the vessel. They were destroyed previously, or during the sinking.

There is no sign of damage to the weapon outside of the fracture location, including no broken cascabel or trunnion, and no apparent signs of sabotage, although complete removal of the gun and total conservation would be necessary to fully confirm this preliminary appraisal.

If the guns were intentionally burst by enemy forces, likely the muzzle would show signs of failure and the burst region would be further forward on the weapon, as would be the result of an obstructed muzzle. Additionally, fractured or missing cascabels or trunnions would indicate possible sabotage, however these are still present on the weapon.

The "E" letter located on the trunnion is not directly connected with any known iron gun foundries. The closest found was Ehrendal Mill in Sweden, which used the markings "EB", "IE", "EC", "IEC", "OEC", "JEC" and sometimes "E BR" (Ehrendals bruk in [kanoner.nu](http://kanoner.nu)). It is not certain if the gun examined is related to this foundry or not. A return to uncover and analyze the other trunnion may lead to further evidence.

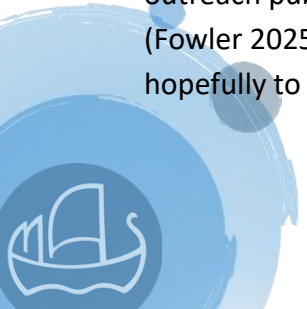
### 3D models of guns



Links to the 3D-models: Examined gun [before](#) and [after](#) decrusting, the [whole site](#) (also in pictures)

### Utilization of the Results

The results of this study were utilized extensively in James Fowler's master's thesis, to be published through East Carolina University, North Carolina, United States. This work was also utilized in a public outreach publication in East Carolina University Maritime Studies Program Publication *Stem to Stern* (Fowler 2025:10<sup>vi</sup>). Further utilization of the results will be used to publish an article on these cannons, hopefully to be presented at the Lost Navy Conference in 2027.





## Conclusion

The failed guns of the *Kronprins Gustav Adolf* are a key aspect to better understand the sinking of the vessel and can be used to further understand the history of Finland and the Swedish Navy. The guns were recorded in high resolution, and the valuable data was used to support James Fowler's master's thesis at East Carolina University. However, more research will be needed to fully determine the origin and history of the two failed guns. A return trip may be in order to revisit the guns and remove more encrustation, to determine where they were made and what their individual histories are. Additionally, valuable data was gathered to aid in further collaboration between East Carolina University and the Maritime Archaeology Society of Finland, which will hopefully pave the way for future cooperation and research.

Espoo 16. 3. 2026, on behalf of the Maritime Archaeological Society of Finland,

James Fowler, ECU Graduate Student

Markku Luoto, Chairman

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## References

<sup>i</sup> Anderson, R. C, 1910, "Naval Wars in the Baltic during the Sailing–Ship Epoch, 1522–1850", C. Gilbert–Wood, London, UK.

<sup>ii</sup> Tredrea, John and Eduard Sozaev, 2010, "Russian Warships in the Age of Sail, 1696–1860: Design, Construction, Careers and Fates", Seaforth, Barnsley, UK.

<sup>iii</sup> Roio, Maili (editor), 2022, "The Invisible Heritage Beneath the Waves: Exploring the Underwater Landscape in the Baltic Sea and Along the Coast of Norway", AS Printon, Tallinn, Estonia.

<sup>iv</sup> Tikkanen Sallamaria, 2000, "Linjalaiva Kronprins Gustav Adolf – 1788 haaksirikkoutunut ruotsalainen sotalaiva", Nautica Fennica 2000, Suomen merimuseo, Helsinki, Finland.

<sup>v</sup> <http://www.kanoner.nu/index.php/ehrendals-bruk/>

<sup>vi</sup> Fowler, James R, 2025, "Exploded Guns, Warships and the Baltic", Stem to Stern 42:10, East Carolina University, USA.

