

In situ preservation: Marstrand 96



Arkeologi i Marstrands hamn 8
Muskeviken
Marstrands socken, Kungälv's kommun
Matthew Gainsford & Delia Ní Chíobháin
Bohusläns museum
Rapport 2011: 30



BOHUSLÄNS
MUSEUM

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Författare Matthew Gainsford & Delia Ni Chiobháin

Grafisk form Gabriella Kalmar

Layout och teknisk redigering Lisa K Larsson

Omslagsbild Utsnitt från ett danskt situationskort som visar den danska flottans angrepp på Marstrand och Carlstens fästning i juli 1719. Upphovsrätt: Det Kgl Biblioteket Köpenhamn, Danmark. Nr XVIII 4.1

Illustration Författarna om inget annat anges

Tryck Bording AB, Borås 2011

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Bohusläns museum

Museigatan 1

Box 403

451 19 Uddevalla

tel 0522-65 65 00, fax 0522-126 73

www.vastarvet.se, www.bohuslansmuseum.se

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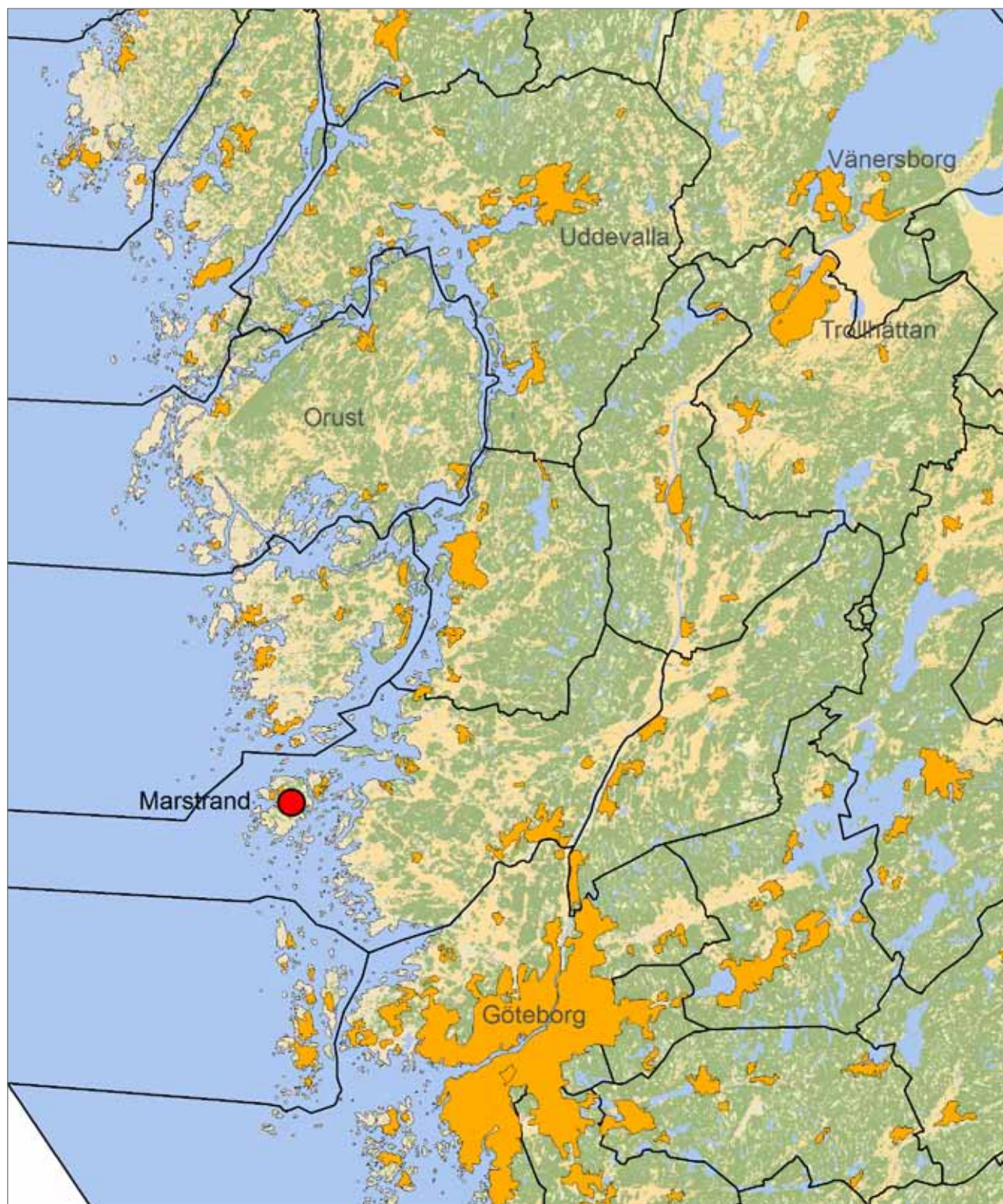


Figure 1. Section of GSD-Property map with the location of Marstrand 96 marked.

Figur 1. Utsnitt ur GSD-Fastighetskartan med platsen för Marstrand 96 markerad.

Svensk sammanfattning

På uppdrag av Kungälv kommun har Bohusläns museum genom Västarvet utfört en skyddstäckning av Marstrand 96 efter beslut av Länsstyrelsen i Västra Götalands län. Fornlämning Marstrand 96 ligger i Muskeviken i Marstrand och utgör lämningen efter ett klinkbyggt fartyg från senare hälften av 1500-talet. Efter en förundersökning 2008, vilken utfördes med anledning av Kungälv kommuns planerade utbyggnad av Muskevicens småbåtsmarina, rekommenderade Bohusläns museum en skyddstäckning av vraket. Lämningen ligger väldigt grunt (0,5-1,5 meter) i ett område som är högtrafikerat och är sedan tidigare delvis skadad genom muddring. För att få underlag till utformningen av skyddet utförde Bohusläns museum en besiktning av lämningen i april 2010. Skyddstäckningen anlades året efter, i april 2011, i samarbete med Väst kustens Brygg & Transport. Skyddet består av beständig geotextil som har förstärkts med nylonband längs kanterna. Geotextilen är säkrad med armeringsjärn genom öljetter längs kanterna och viktad med betongplattor. Denna metod har använts tidigare av Bohusläns museum med gott resultat. Bohusläns museum rekommenderar dock att skyddet besiktigas med två års intervall för att kontrollera dess beständighet.

Background

In April of 2011 Bohusläns museum through Västarvet undertook *in situ* preservation of an archaeological shipwreck in Muskeviken, Marstrand harbour, Kungälv kommun (figures 1 and 2). Bohusläns museum was contracted by Kungälv kommun to undertake *in situ* preservation measures. Marstrand 96 contains the remains of a clinker built vessel dated to the late 1500s. The site was first archaeologically recorded in 2008 by Bohusläns museum in response to Kungälv kommuns planned extension to the small boats harbour. Following a preliminary investigation it was recommended that the site be preserved *in situ* from further erosion (Bergstrand 2008).

Following are the processes by which Marstrand 96 was preserved *in situ* with a protective covering of geotextile; the purpose of covering the site is to protect the ships timbers from further physical and biological erosion and degradation and to stabilise its environment. Similar protective coverings have been placed over various shipwreck sites along the Swedish west coast, for example Färjevraket, Marstrand; *Havmanden*, Risö; and Skaftövraket, Skaftö.



Figure 2. Section of GSD-Property map with location of Marstrand 96 marked. Scale 1:20 000. Permission for distribution approved by the Security Officer. Lantmäteriet 2011-09-01. Dnr 601-2011/2317.

Figur 2. Utsnitt ur GSD-Fastighetskartan med platsen för Marstrand 96 markerad. Skala 1:20 000. Godkänd ur sekretessynpunkt för spridning. Lantmäteriet 2011-09-01. Dnr 601-2011/2317.

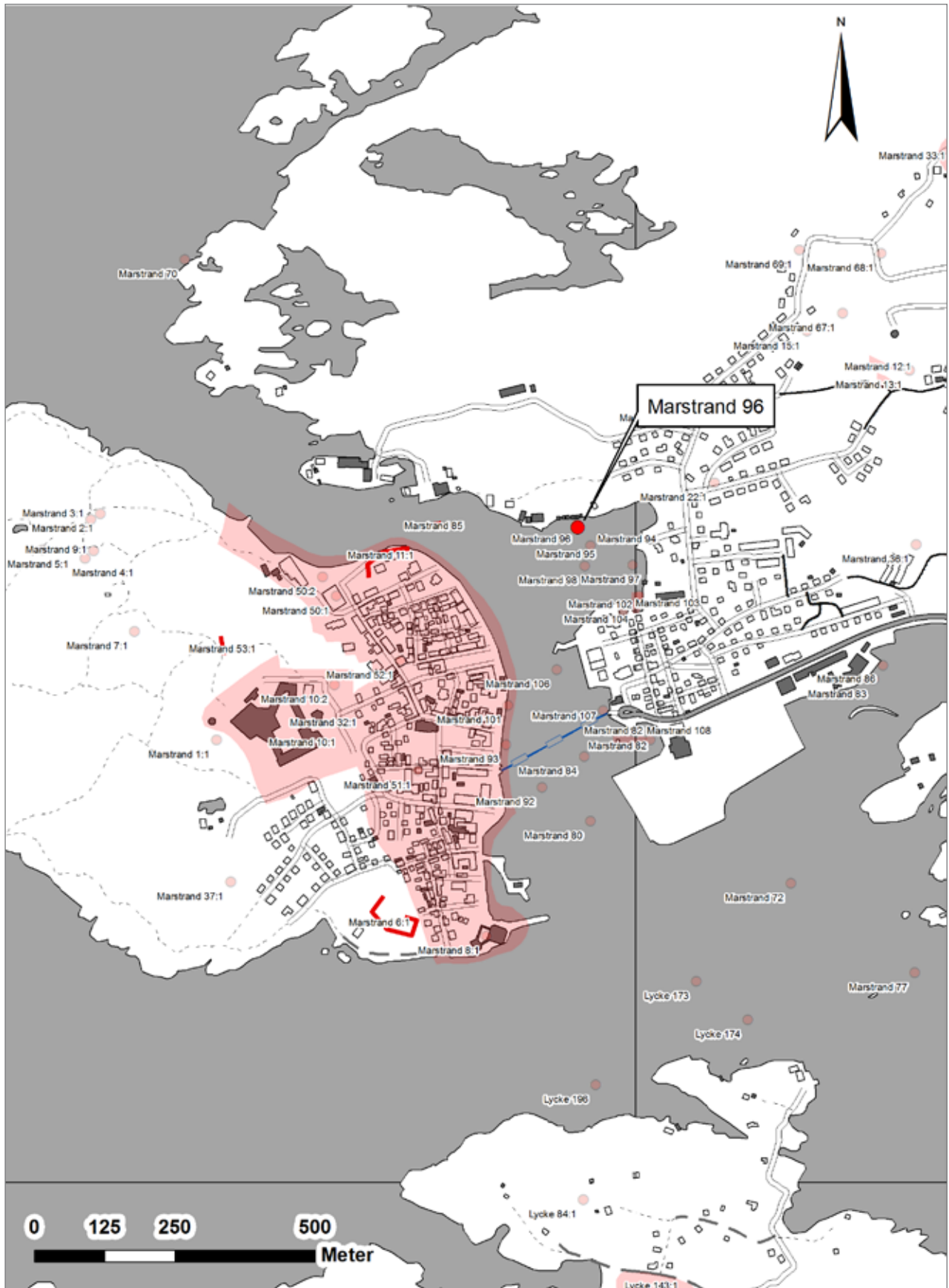


Figure 3. Section from GSD-Property map, sheets 7A 5j, 7A 5a, with Marstrand 96 and nearby ancient remains marked. Scale 1:5 000. Permission for distribution approved by the Security Officer. Lantmäteriet 2011-09-01. Dnr 601-2011/2317.

Figur 3. Utsnitt ur GSD-Fastighetskartan, blad 7A 5j, 7A 5a, med undersökningsområdet samt de närliggande fornlämningarna markerade. Skala 1:5 000. Godkänd ur sekretessynpunkt för spridning. Lantmäteriet 2011-09-01. Dnr 601-2011/2317.

Landscape

Natural landscape

Marstrand was originally established on the eastern side of Marstrand Island, but has since grown to include a settlement on nearby Koön. The sound between Marstrand Island and Koön divides the community into two and as a result forms Marstrand's harbour.

At its narrowest point the sound spans no more than 100 meters across. Around both Marstrand Island and Koön the water depth of surrounding the quaysides varies between 2-5 meters. The maximum water depth, at the centre of the sound, is 12-13 meters. Soft sediments predominate in the sound whilst occasional shallow areas can contain a mixture of gravel and sand. Stretching out from Koön, halfway into the sound, is a ridge that connects it to Marstrand Island. This is distinguished by a bottom profile which illustrates that the seabed here is almost two meters higher than the surrounding seabed; this has a limited sedimentation of approximately 0.1-0.2 meters.

Muskeviken is a bay located on the western side of Koön approximately 200 × 200 meters (40 000 square meters) in area. Its northern shoreline consists of a high outcrop of bedrock while the eastern and southern areas accommodate urban and port activities. Recent coastal deposition has transformed the area and reduced the bay in size. In the central area of the bay water depth varies between 2 and 2.5 meters. Sediment substrate is relatively uniform across the whole survey area with the upper half meter consisting of soft muddy sediment.

Cultural environment

Marstrand port has the highest concentration of underwater archaeological remains in relation to area on the west coast of Sweden (figure 3). Aside from the national monument Carlsten fortress (*Carlstens fästning*), a large area of old Marstrand (Marstrand 32) can be identified by cultural layers. Archaeological research conducted over the past decade has revealed that Marstrand 32 also includes large parts of the port itself, however the extent of which is as yet unknown. Excavations focusing on the cultural layers have examined a volume of 10 m³ and have yielded over 1 500 artefacts. Most common find categories have been bones, ceramic, glass and clay pipes along with a lesser amount of wood, metal, leather, other organic material and rocks. The oldest stratum has been dated to the 1500s while the later layers have been dated to the 1600s, 1700s, 1800s and the 1900s (Bergstrand 2009a).

In addition to extensive cultural layers in the port, there are 17 known historic shipwreck remains that are dated from the late 1500s until at least the 1700s (appendix 1). All of these sites are designated archaeological monuments and eight of the wreck sites are located within Muskeviken. Three sites – *Halmstad*, *Stettin* and *Kalmar* – were Swedish Navy frigates,

which sank in 1719 (Marstrand 80, 92, 85). Another frigate, *Fredricus*, was investigated in 1998 by Bohusläns Museum (Marstrand 93); its preserved section of the hull lies under a mound of stones north of the ferry landing on Marstrand Island.

The remaining wreck sites have working titles; Kölvraket (lacking registration but possibly identical to Marstrand 84), Färjevraket (Marstrand 83), Brännaren (Lycke 196), Stävvraket (Marstrand 101), and the Muskeviken wrecks (Marstrand 94, 95, 96, 97, 98, 102, 104, 105). Kölvraket is dendrochronologically dated to approximately 1500, Färjevraket is dated to the 1600s, Stävvraket to 1610-1624, while the Brännaren wreck is undated. The latter is estimated to be from the 1600s to the 1700s. In Muskeviken four sites are dated: Marstrand 97 and 102 are dated to the first half of the 1600s, Marstrand 94 to the latter half of the same century, while Marstrand 96 is dated to the latter half of the 1500s.

Additionally, remains of another vessel were destroyed by dredging in 1981 (Marstrand 82). Unfortunately only limited documentation was conducted of the remains (Lisberg Jensen 1981).

Historical source material

The earliest written source material on Marstrand is from the 1200s (Unger & Huitfeldt 1864: DN 6, 57), indicating that some settlements had been established around the natural harbour. From the year 1291 there is a reference to “minoriternas kyrka i Marstrand”, that is, an abbey, which confirms the existence of a settlement and also provides an indication to its importance. As a general rule Franciscan abbeys were established in relatively large settlements. From the 1300s onwards Marstrand is mentioned in administrative and political contexts suggesting that the city developed into an independent administrative unit (Svenskt diplomatarium: DS 8, 6819; Lange & Unger 1855: DN 3, 806).

Marstrands' founding has been associated with changes in shipping and trade that took place during the late 1100s and 1200s. Marstrands' location within Bohusläns outer islands and skerries, along with a suitable natural harbour, established it as an important transit harbour for regional shipping. It was during one of the more well documented herring periods, in the late 1500s, that Marstrand reached a prominent position in Bohuslän as a trade and transit port for foreign shipping. This dominance was also evident during the herring fishing season of the 1700s when it remained Sweden's only free port in the later part of that century (Holmberg 1963:149 ff). The towns' importance remained high during the early modern period, including during the construction of Carlsten fortress. Marstrand harbour was periodically used as a base for part of the Swedish west coast fleet.

A consequence of its central role as a transit port and a military foothold resulted in the city being repeatedly embroiled in conflict. Among

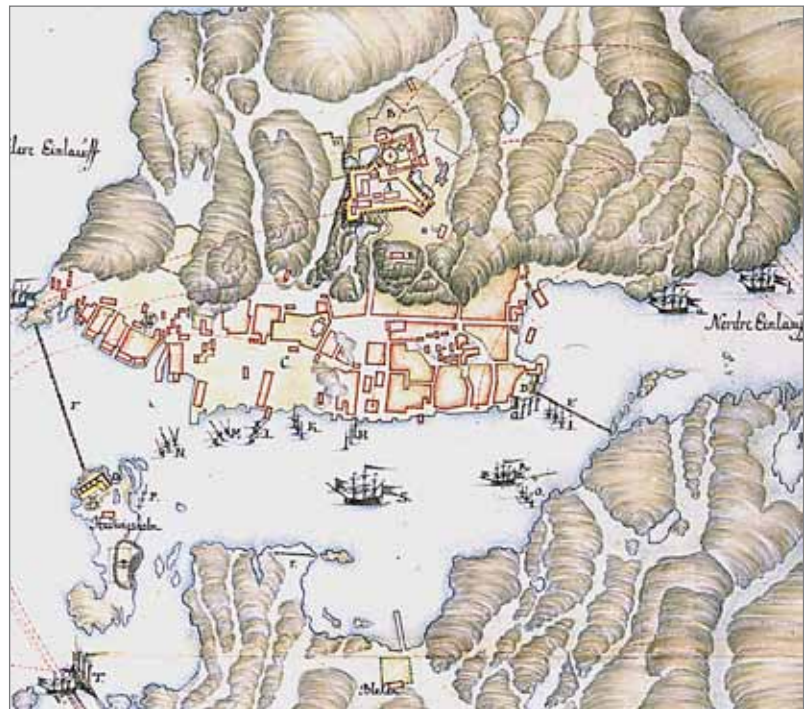


Figure 4. A Danish so-called situation map which shows the Danish Navy's attack on Marstrand and Carlstens fortress in July 1719. The map is thought to be contemporaneous with the event. The mast tops of some sunken Swedish vessels are visible in the port area. Source: Royal library, Copenhagen, Denmark. Nr XVIII 4.1 Marstrand C. The image is cropped.

Figur 4. Ett danskt så kallat situationskort som visar den danska flottans angrepp på Marstrand och Carlstens fästning i juli 1719. Kortet förmodas vara samtida med händelsen. Inom hamnområdet syns masttoppar till ett antal sänkta svenska örlogsfartyg. Arkiv: Kungliga biblioteket, Köpenhamn, Danmark. Nr XVIII 4.1 Marstrand C. Bilden är beskuren.

the most notable conflicts are two Danish attacks, one during the Gyldenlöwefejden in 1677 and another in 1719 when the Danish fleet besieged the city until the fort garrison finally capitulated (Holmberg 1963:235-262). The latter event has been attributed to one of Denmark's greatest naval heroes, Peder Wessel Thordenskiold, who, in addition to the siege of Marstrand in 1719, was also responsible for several attacks against Sweden's western interests in the Great Northern War (1700-1721).

It was also in connection with the siege of Marstrand in 1719 that large parts of the Swedish west coast fleet were lost. Several Swedish vessels were trapped within the harbour, and most likely at a disadvantage. It was decided on the basis of a tactical stance to order the sinking of Swedish ships rather than risk them being captured by the enemy (Ribbing 1949:151). A contemporary Danish *situationskort* (map) of the city and harbour (figure 4) illustrates clearly what vessels sunk, and where:

frigates *Halmstad* (46), *Settin* (46), *Kalmar* (46), *Fredricus* (36) and *Charlotta* (30); the galleys *Stå Bra* (9) and *Greve Mörner* (9); the yacht *Diana* (4) and two fire ships (Ribbing 1949:151). Numbers after the names indicate the number of guns the ships are believed to have been armed with. One of the sunken fire ships is allocated a location on the *situationskort* where today a known wreck site lies, north of Klåverön (Lycke 196). The second fire ship on the *situationskort* is located directly north of Hedvigsholmen. Most likely this area was filled during modern times when large areas of Arvidsvik were reclaimed. However, it cannot be completely ruled out that the remains of a vessel dredged up in 1981 (Marstrand 82) is the aforementioned fire ship. Ship remains from four of the large sunken frigates *Halmstad*, *Settin*, *Kalmar* and *Fredricus* (Marstrand 80, 92, 85, 93) have been located in modern times to form an almost unique resource of information on the events which took place in Marstrand 1719.

Previous investigations

Earlier archaeological investigations on Marstrand Island are relatively few due to low development of the older wooden town. However, some noteworthy excavations have been conducted; for example, Kristina Carlsson's excavation of Drottninggatan in 1981 (Carlsson 1984) and Margaret Hasselmo's report on Marstrand in the series *Medeltidsstaden* (Hasselmo 1980).

As early as 1958, during dredging work for the Koön ferry berth, archaeological ship remains were uncovered; probably the remains of the so-called Färjevirket (Marstrand 83). There is uncertainty however as to whether the remains constitute one or two wreck sites. Items located include a fragment of a keel, a rudder and a breech loading cannon. Dredging operations in Arvidsvik on Koön in 1981 for a gas station revealed the presence of a larger vessel which was later examined by the Sjöfartsmuseet in Göteborg (Marstrand 82). However, results from the documentation are relatively rudimentary and do not provide enough direct evidence to indicate its characteristics or age (Lisberg Jensen 1981).

During the 1970s and 1980s sport diving activities led to the rediscovery of several sunken warships. Information about the Muskeviken wrecks has been provided by the avocational diving group *Marinarkeologiska sällskapet, Göteborgskretsen* (MASG), whose documentation provided a better understanding of the remains. An inventory of Coast Guard divers in the late 1990s also acknowledged the existence of ship remains and/or timber structures. These remains have been associated with current investigations concerning the sites Marstrand 94, 95, 96, 97 and 98.

It was not until 1997 that an accurate archaeological investigation was carried out in the port. The investigations arose from plans to construct two large stone underwater retaining embankments outside the

quay on Marstrand Island. Proposed development resulted in a preliminary investigation of harbour cultural layers and two wreck sites (Bergstrand 2007a, 2007b). In 1998 an excavation was carried out on *Fredricus* (Marstrand 93), in conjunction with a partial survey of harbour cultural layers, and a preliminary investigation of harbour cultural layers associated with the quay (Marstrand 32) where a boat stem, together with fragments of planking, was located (Bergstrand 2009a and forthcoming report). Also during the same year an *in situ* preservation project was carried out on the wreck with the working title Färjevraket (Report forthcoming).

The following year, 1999, an investigation was conducted in Arvidsvik in connection with Hedvigsholmen on Koön (Bergstrand 2009b). It was not until 2008 before new developments would result in further archaeological efforts. In addition to harbour developments in Muskeviken, further investigations have also been carried out in the area a result of planned laying of fibre optic cable through the northern inlet of Marstrand and under Muskeviken (Gainsford 2009).

Marstrand 96 was discovered during inventories by *Marinarkeologiska sällskapet, Göteborgskretsen (MASG)* in Marstrand. An inventory by the Coast Guard during the late 1990s also provided evidence for the presence of shipwrecks and/or other wooden structures within the bay. A further four shipwrecks, Marstrand 94, 95, 96, 97, 98, and extension to cultural layers of Marstrand 32 were the results of these inventories. In the 2008 report, Marstrand 96 and 97 were recommended to be protected *in situ* preventing further erosion and degradation of the sites (Bergstrand 2008).

Wrecks Marstrand 102, 104 and 105 were discovered during a preliminary archaeological investigation in 2010 and consist of three clinker-built vessels, one of which (Marstrand 102) has been dated to the early 1600s. During the same investigation cultural layers (Marstrand 103) were also located in the vicinity of the wrecks. Marstrand 103 was similar to the cultural layers of Marstrand 32 but contained a larger share of certain finds, such as ceramics, wooden chips and ballast flint (Ní Chíobháin 2010).

Marstrand 96

Marstrand 96 is located in Muskeviken on Koön, Marstrand. It lies on an SW-NE axis in 0.5 to 1.5 meters of water on its port side. Its length has been measured to circa 20 meters; its breadth is yet undetermined. Towards the south-west the site is more protected by ballast and sediment compared to the north-western end that is somewhat more degraded. Exposed remains are the keel, floor-riders, garboard strakes and fragments of planking as well as the keelson. Its middle section has been removed via dredging with just the keel and garboard strake surviving. At this point a section of the keel is hanging free in midwater (appendix 3).



Figure 5. Underwater photo of Marstrand 96. Photo Staffan von Arbin, Bohusläns museum.

Figur 5. Undervattensbild av Marstrand 96. Foto Staffan von Arbin, Bohusläns museum.

Method

Marstrand 96 was inspected on 14 April 2010 by maritime archaeologists from Bohusläns museum. The objective was to measure the extent of the site and to determine the amount of materials that would be needed for the protective covering and to create a deployment strategy that would best suit the site in its current condition (appendix 3). A strategy was thus formulated that utilised proven techniques for preservation of archaeological sites in western Sweden. Sandbags would be required along the keel (especially where it hung free over the bottom) at a length of around six meters. Strengthened geotextile would then be laid over the remains with overlap, weighed down with concrete weights and fastened to the bottom with lengths of reinforcing iron. This type of *in situ* preservation has been conducted most recently on the Skaftö wreck in Bohuslän. It also has a record of being a long lasting and stable form of protection. Field work was carried out on 13 April 2011 in co-operation with Väst kustens Brygg & Transport who supported with materials, divers and a working platform.



*Figure 6. Inspection dives of the Marstrand 96 site.
Photo Matthew Gainsford, Bohusläns museum.*

*Figur 6. Besiktningdyk på Marstrand 96.
Foto Matthew Gainsford, Bohusläns museum.*

Results

Exposed sections of the hull that were in dire need of protection are about twelve meters long. The free hanging section of the keel (a length of 1-2 meters) was supported by sandbags before it was covered in geotextile. Along the whole of the north-western section of the keel sandbags were laid to further stabilise remaining sections, a total of six meters. Sandbags used were of the same material as the geotextile so as to not affect the preservation conditions of the site. In total 30 sandbags were used to support the remaining hull. After sandbagging geotextile strengthened with nylon bands and eyelets was used to entirely cover the site, an area of 15 meters long and 5 meters wide; this allowing for excess to drape over the extremities of the site. Type of geotextile used was a Polyfelt TS30 non-woven water permeable geotextile with a high durability that could be rolled out easily over a sensitive site (appendix 4). Geotextile was weighted down with concrete weights (350 × 350 × 40 mm) and fastened along the edges with iron reinforcing rods (figures 6-9). A total of 100 concrete weights and 50 reinforcing rods were used.

During an inspection to Marstrand in May 2011 maritime archaeologists from Bohusläns museum inspected the site briefly from the surface, since the site is easily visible. The protective covering remains in place and does not buckle up in any area. The weights remain in place and are mostly evenly distributed.



Figure 7. Sandbags used to stabilise the site.
Photo Staffan von Arbin, Bohusläns museum.

Figur 7. Sandsäckar för stabiliseringen av lämningen.
Foto Staffan von Arbin , Bohusläns museum.



Figure 8. Geotextile protective covering.
Photo Staffan von Arbin, Bohusläns museum.

Figur 8. Den geotextil som användes för att skydda vraket.
Foto Staffan von Arbin , Bohusläns museum.



Figure 9. Concrete weights used for weighing down the geotextile.
Photo Staffan von Arbin, Bohusläns museum.

Figur 9. Betongplattor användes för att vikta ned geotextilen.
Foto Staffan von Arbin , Bohusläns museum.



Figure 10. Iron reinforcing rods were used to secure the edges of the geotextile. Photo Staffan von Arbin, Bohusläns museum.

Figur 10. Med hjälp av armeringsjärn säkrades geotextilens kanter. Foto Staffan von Arbin , Bohusläns museum.

Discussion

As a method for the *in situ* preservation of ship wreck sites on the west coast of Sweden this method has proven thus far to be cheap and effective, especially in relatively protected waters. With respect to Marstrand 96 only time will tell as to the coverings durability. Boat traffic within Muskeviken, although minimal as yet, has not affected the site; it is factors such as these, for example location, environment, weather *et cetera* that affect the long term durability of similar coverings. It however lies in a protected although somewhat shallow bay.

Similar coverings have also been used on *Havmanden*, Skaftövraket and Färjevraket. Skaftövraket and *Havmanden* are more exposed to weather and the Färjevraket from the Marstrand ferry prop wash. *Havmandens* covering has partially lifted from the site, some weights have been moved by environmental factors and some of the covering has eroded away, most prominently around the brick stacks (inspection October 2010). Skaftövraket's covering thus far is intact (inspection May 2011) with a thin layer of silt and algae covering the goetextile and the weights have remained in place. Färjevraket was also inspected in May 2011. Its covering remained intact with minimal impact from the ferry and its propwash. The covering was hard to differentiate from the surrounding environment and only a small portion of the site was exposed to the environment.

In order for an *in situ* strategy to work a system for the periodic inspection and maintenance of the site preserved *in situ* has to be developed and maintained for each site. It is therefore recommended that Marstrand 96 be revisited on a regular basis, preferably every second year, to ascertain the condition of the site and its covering.

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Technical and administrative data

Lst dnr:	431-110131-2007
Västarvet dnr:	NOK 297-2010
Västarvet pnr:	GE183
Fornlämningsnr:	Marstrand 96
Län:	Västra Götalands län
Kommun:	Kungälv
Socken:	Marstrand
Fastighet:	Muskeviken, vattenområde i Marstrands hamn
Ek. karta:	7A 5j, 7A 5a
Läge:	X 6426100, Y 1249900
Meter över havet:	-0,5--1,5 m
Koordinatsystem:	RT 90, 2,5g V
Uppdragsgivare:	Kungälv kommun
Ansvarig institution:	Bohusläns museum
Projektledare:	Staffan von Arbin
Fältpersonal:	Staffan von Arbin, Thomas Bergstrand, Delia Ní Chíobháin, Matthew Gainsford
Konsult:	Västkustens Brygg & Transport
Fältarbetstid:	14 april 2010, 13 april 2011
Arkeologtimmar:	48
Arkiv:	Bohusläns museums arkiv
Fynd:	Inga fynd omhändertogs

Appendices

Appendix 1. *Aerial photo with Marstrand wrecks overlaid*

Appendix 2. *Schematic plan of the geotextile*

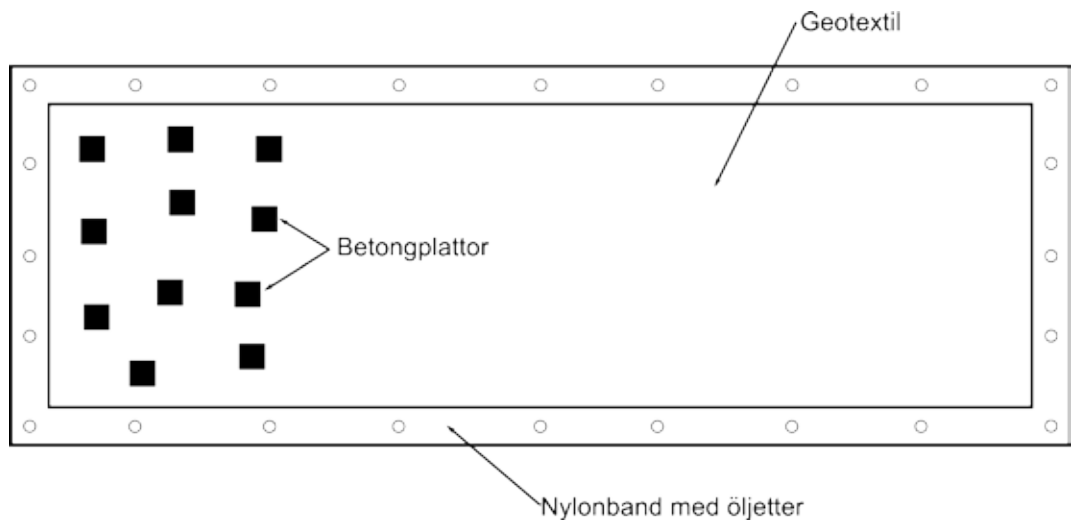
Appendix 3. *Notes on the in situ protection of Marstrand 96*

Appendix 4. *Technical specification of the geotextile*

Appendix 1. Aerial photo with Marstrand wrecks overlaid



Appendix 2. Schematic plan of the geotextile



PM rörande skyddstäckning av del av Marstrand 96

Besiktning utförd 2010-04-15

Beskrivning av vraket

Längden på vraket kan utifrån tidigare mätningar uppskattas till cirka 20 meter. Bredden är inte känd. Lämningen är orienterad i SV–NO riktning och är belägen på mellan 0,5 och 1,5 meters vattendjup. Fartygslämningen har tippat mot nordväst och ligger som det verkar helt på sidan. Den sydvästra delen av skeppskonstruktionen bedöms ligga väl skyddad under barlast och sediment. Den exponerade delen av konstruktionen består av köl, bottenstockar, sambord fragment av bordläggning samt kölsvin. Mittpartiet av konstruktionen är söndermuddrad och endast kölen och samborden är här bevarade. Här hänger en del av kölen fritt utmed en kortare sträcka. Avståndet mellan köl och botten är ca 20 cm.

Rekommendation

Den fritt ”hängande” delen av kölen, vilken har en längd av 1–2 meter, bör innan övertäckning stagas upp underifrån med hjälp av sandsäckar. Förslagsvis läggs även en rad med sandsäckar längs hela den exponerade nordvästra sidan av kölen för att stabilisera denna. Denna sträcka är beräknad till cirka 6 meter. Det exponerade skrovpartiet som är i behov av skyddstäckning är omkring 12 meter långt. En 15 meter lång och 5 meter bred geotextil bör därför mer än väl räcka för att täcka detta parti. Problemet är att få duken att ligga kvar på plats, i synnerhet på det grundaste partiet där vattendjupet är omkring 0,5 meter och påverkan av is och sjöhävning är mest påtaglig.

Bohusläns museums förslag är att duken förstärks med nylonband utmed sidorna och eventuellt i kryss över duken. Dessutom föreslås att duken förses med öljetter varje meter längs sidorna. Dessa kan användas för förankring av duken med hjälp av armeringsjärn. Utöver dessa järn bör duken viktas med betongplattor av storlek cirka 350×350×40 mm. Åtgången av plattor beräknas till åtminstone en per kvadratmeter vilket ger ett minimum av **75 stycken**. För att ha lite marginal bör beställningen lämpligen omfatta **100 betongplattor** och **50 stycken halvmeterlånga armeringsjärn**.

Den geotextil som används bör vara en icke-vävd vattengenomsläpplig geotextil med hög beständighet. Samtidigt måste den vara så pass flexibel att den enkelt låter sig rullas ut över fartygslämningen. Sandsäckar bör vara av ett beständigt syntetmaterial, inte bomull, linne eller liknande. Jag vet inte vilka storlekar de kommer i, men en hanterbar storlek skulle kunna vara ca 400×300×200 mm, vilket skulle ge omkring 20 säckar – låt oss säga **25 stycken för säkerhets skull**. De bör inte fyllas fullt utan fortfarande vara något flexibla/formbara.

2010-04-20

Staffan von Arbin

Tekniska Data

polyfelt.TS

500 536 | 03.2002 | SE-FLA



polyfelt[®]
Geosynthetics

polyfelt.TS är nålfiltade geotextiler av 100% ändlösa, UV-stabiliserade polypropen-fibrer. De karakteriseras av stor resistens mot installationskador, hög permeabilitet och ökad resistens mot UV-strålning.

Egenskap	Enhet		TS 10	TS 30	TS 65
Produkt	-		Nålfiltad geotextil av 100% ändlösa fibrer		
Råmaterial	-		100% UV-stabiliserad polypropen		
Vikt [EN 965]	g/m ²		105	155	285
Tjocklek under belastning [ISO 9863]	2 kPa 20 kPa 200 kPa	mm mm mm	1,0 0,7 0,4	1,5 1,0 0,6	2,5 1,7 1,1
CBR-test [EN ISO 12236]	x [*] -s x [*]	N N	1050 1175	1550 1750	3000 3300
Rems-draghållfasthet [EN ISO 10319]	kN/m		7,5	11,5	21,5
Brottöjning [EN ISO 10319]	md cd	% %	75 35	75 35	80 40
Fallprov (håldiameter) [EN 918]	mm		34	25	17
Bruksklass [Väg 94]	-		2	3	4
Effektiv öppningsvidd O ₉₀ [EN ISO 12956]	mm		0,13	0,12	0,09
Genomsläpplighet vinkelrätt mot duken (Δh = 50 mm) [EN ISO 11058]	2 kPa	mm/s l/m ² s	130	100	65
Genomsläpplighet i dukens plan [EN ISO 12958]	20 kPa 200 kPa	10 ⁻⁷ m/s l/m.h 10 ⁻⁷ m/s l/m.h	6 2,2 2 0,4	20 7,2 6 0,6	40 14,4 9 1,1

Angivna värden är medelvärden av resultat från interna prov, och provningar vid externa oberoende laboratorier. Polyfelt Ges.m.b.H. förbehåller sig rätten till ändringar.

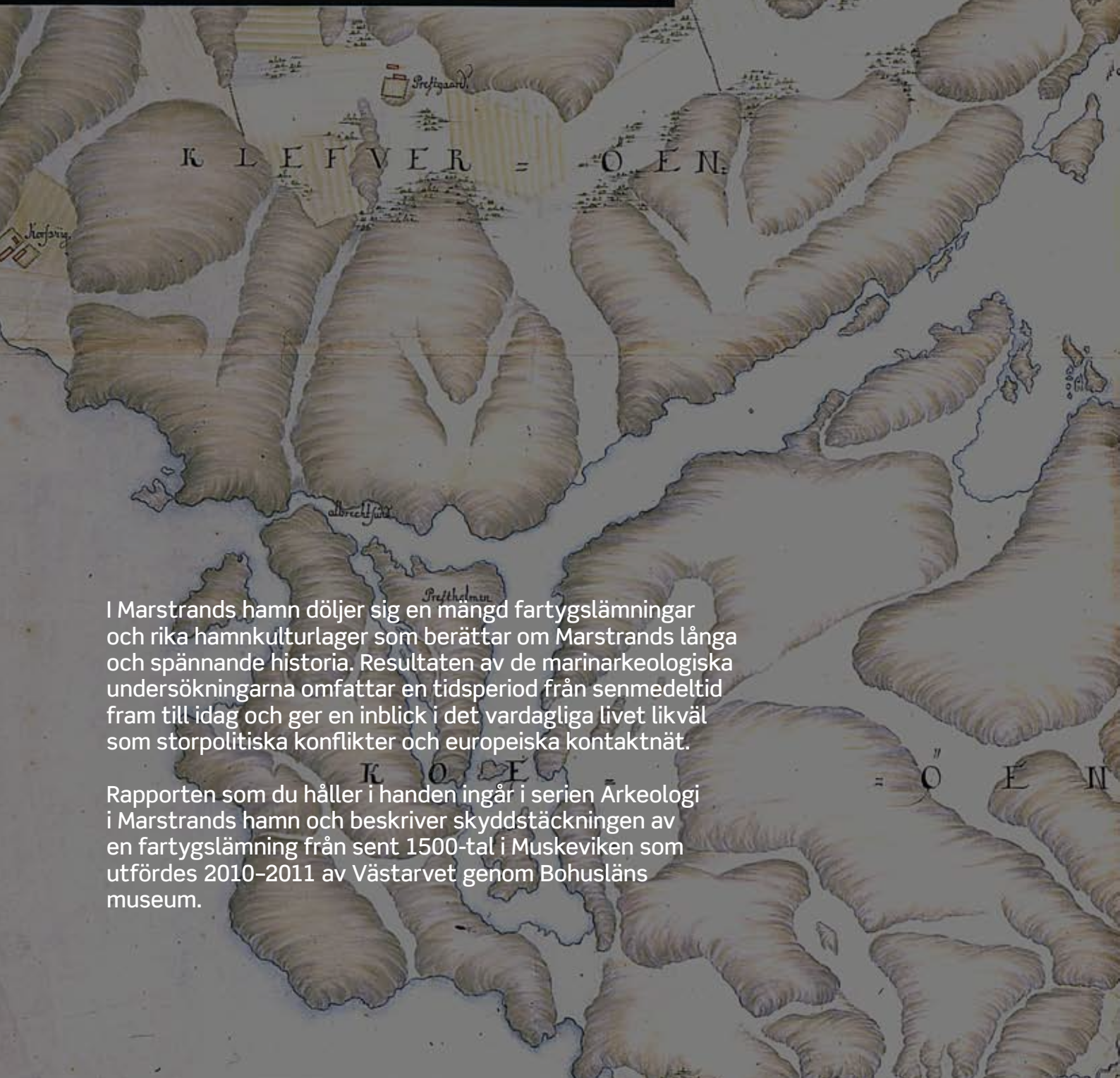
Dimensioner	Enhet	TS 10		TS 10-s	TS 30		TS 30-s	TS 65		TS 65-s
Längd	m	200	200	150	150	150	100	125	125	125
Bredd	m	2	4	5	2	4	5	2	4	5
Yta	m ²	400	800	750	300	600	500	250	500	625
Rullvikt	kg	45	90	85	50	99	85	76	153	187
Rulldiameter	m	0,3	0,3	0,3	0,3	0,3	0,3	0,5	0,5	0,5

den der Festung Carlsten namunto CHRISTIANSTEIN. nebst die Stadt Mastrandt, und deren umlyegende Situation, wie die Insel zu gleich mit der im Hafen liggenden Schwedischen Flotte, von dem Scheidtsnacht Torden Schieldt den 26 Julij 1719, ist Attaquirt, und den 27 Julij, Persecor anthon Königi, Mayestet zu Denemarcks Bourgen, übergangen.

Die Festung CHRISTIANSTEIN.
 Centre George ist von den Schweden Sellen, wieder besetzt.
 Die Stadt Mastrandt
 Dattena die Einläuff des Hafens zu bestrichen.
 ein Baum von Masthauwe, jahr den 1707 von einläuff des Hafens
 einen Baum von Labettow mittlern übergen, jahr den 1707 von einläuff
 groß Moner N. Maastroffen seit 2 Salween welche verfehlet.
 Calank thelle L. Frickon M. Sullen N. Kaly die Drigalle langschiff.
 Ingette Mikaltrina Sallay, Känd De 2 Branders gleichfalls von einläuff
 Ingette Elisabeth Sallay, S. Königs Schiff Durborg, und T. Sallay
 Prince Friderick von Kopen Sines erobert.
 der pruden, Sillay, welcher wegen des Branders an sich auf dem gnuß
 by N. Sellen misse.

- a. Prince Georg, h. Knaustropen König, Dahnische pruden se zu erst.
- c. Sallay, Sillay, von dem nachschiff die Dahnische Flotte in der Mitte eingeworfen, und hernacher in die Stadt Billa gefasst.
- d. sechs stück langemahren Durborg, so die Dahnische Durborg.
- e. Fridericks hall, f. Knapen von den König, Dahnische pruden.
- g. Durborg, h. Sellen, Pruden, Dahnische pruden, i. Sellen, Dahnische pruden, die eingeworfen Schwedische Schiff, welche in der Mitte von der Dahnischen Flotte auf dem Hafens Durborg und hinterhol Ven. gefasst.
- h. Sellen, Dahnische pruden, Sellen, Sellen, nachschiff, Dahnische pruden.
- n. Die Transport Schiffe welche die Dahnische Flotte in der Mitte gefasst.
- o. Durborg, welche Dahnische pruden, p. so sie die Dahnische pruden.
- q. eine Sellen, Dahnische pruden, r. der Dahnische pruden, Dahnische pruden.

Maßstab von 100 Schickelsch Schotten.
 100 200 300 400 500 600 700 800 900 1000



I Marstrands hamn döljer sig en mängd fartygslämningar och rika hamnkulturlager som berättar om Marstrands långa och spännande historia. Resultaten av de marinarknologiska undersökningarna omfattar en tidsperiod från senmedeltid fram till idag och ger en inblick i det vardagliga livet likväl som storpolitiska konflikter och europeiska kontaktnät.

Rapporten som du håller i handen ingår i serien Arkeologi i Marstrands hamn och beskriver skyddstäckningen av en fartygslämning från sent 1500-tal i Muskeviken som utfördes 2010-2011 av Västarvet genom Bohusläns museum.