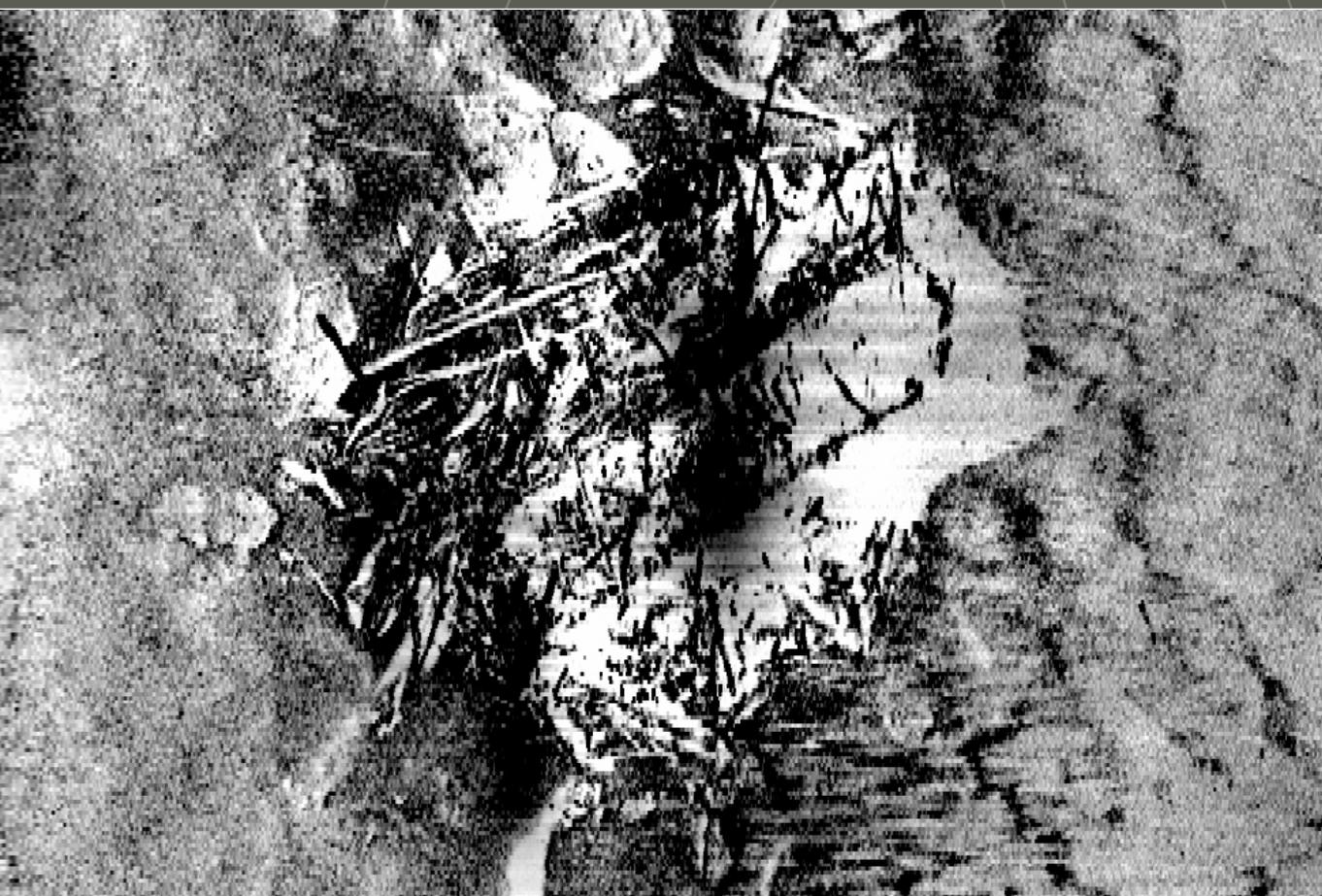


ENERGY ISLAND BORNHOLM  
Geoarchaeological Analysis of Energy Island Bornholm  
Wind Farm Bornholm II

VIR 2937



John Howorth



VIKINGESKIBS  
MUSEET

***ENERGY ISLAND BORNHOLM***  
***Geoarchaeological Analysis of Energy Island Bornholm***  
***Wind Farm Bornholm II (BH2)***

***VIR 2937***

***John Howorth***

July 2023

Cover illustration: Sidescan sonar image SSS\_BH2\_BLOCK10\_0019. © Vikingskibsmuseet.

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VIR 2937

ENERGY ISLAND BORNHOLM

WIND FARM BORNHOLM II (BH2)

STED- OG LOK. NR. 401754-347

## Geoarchaeological Analysis of Energy Island Bornholm – Wind Farm Bornholm II (BH2)

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## **Abstract**

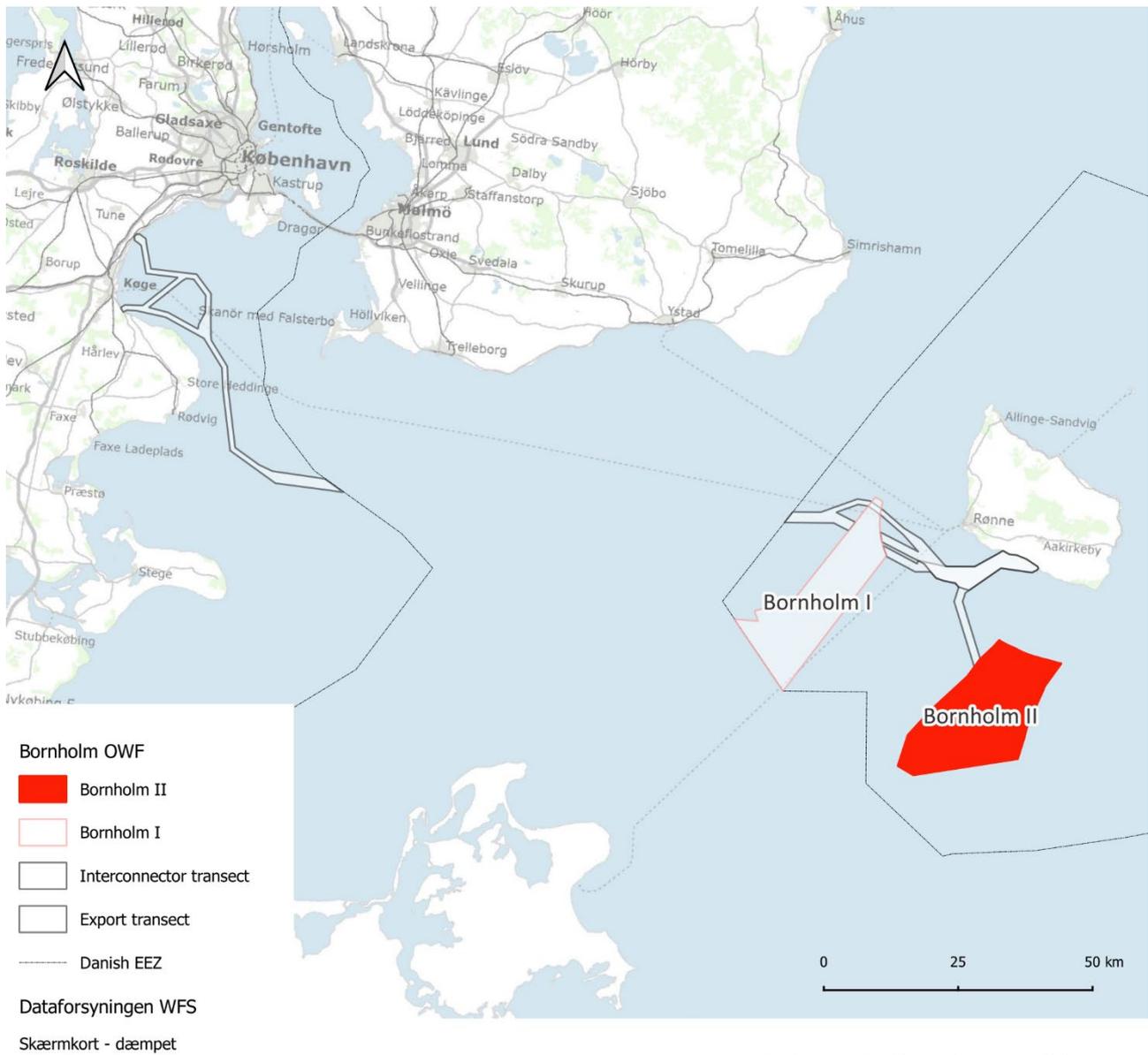
Energinet has requested that the Viking Ship Museum (VIR) identify potential cultural historical objects (CHOs) located at the planned wind farm sites and related cable routes of the Energy Island Bornholm. This report covers the eastern wind farm: Bornholm II, or BH2 for short.

The Viking Ship Museum has identified a number of possible CHOs on the seabed in the geophysical data, including 38 potential wrecks, 11 potential anchors and 42 mounds plus 7 so-called "mound-no-height". Moreover, the paleo-terrain that best represents the terrain during the Late Palaeolithic and Early Mesolithic, between c. 9400 BC and 8400 BC, was analysed and a number of potential settlement 'hotspots' were highlighted.

## **Dansk resumé**

Energinet har anmodet Vikingeskibsmuseet (VIR) om at identificere potentielle kulturhistoriske objekter i den planlagte Vindmøllepark *Bornholm Energiø* og dens kabelkorridorer i Østersøen. Nuværende rapport dækker den østre vindmøllepark: Bornholm 2 eller BH2.

Vikingeskibsmuseet har identificeret et antal potentielle kulturhistoriske objekter, heraf 38 potentielle vrage, 11 potentielle ankre, 42 "mound" og 7 "mound-no-height" (bunke, bunke uden højde). Desuden er et palæo-terræn, tolket som den bedste repræsentation af terrænoverfladen i sen Palæolitikum, tidlig Mesolitikum mellem ca. 9400 BC og 8400 BC, blevet analyseret og steder udpeget for potentielle bosættelses-"hotspots".



Contains data from Styrelsen for Dataforsyning og Effektivisering

**Figure 1. Map showing the areas included in the Energy Island Bornholm. Bornholm 2 is coloured red. Illustration: Marie Jonsson © Vikingeskibsmuseet.**

## Introduction

Following a decision by the Danish Parliament in June 2020, Denmark is on the path to establishing offshore energy infrastructure in the Danish North Sea and the Danish Baltic Sea to connect offshore wind energy to the Danish mainland and to neighbouring countries via offshore energy hubs called *Energy Islands*. In the Baltic Sea, the Energy island is the existing island of Bornholm.

**Table 1 Abbreviations used in the text.**

<b>Initials:</b>	<b>English:</b>	<b>Danish:</b>
CHO	Cultural historical object	Kulturhistorisk objekt
DMA	Danish Maritime Authority	Søfartsstyrelsen
EEZ	Exclusive Economic Zone	Eksklusiv økonomisk zone
FF	Danish national registry of CHO finds	Fund og Fortidsminder
GIS	Geographical information system	Geografisk informationssystem
HF	High frequency	Højfrekvent
MAG	Magnetometer, magnetic	Magnetometer, magnetisk
MBES	Multibeam echo sounder	Flerstråleekkolod
MMO	Man-made object	Menneskeskabt objekt
ROV	Remotely operated vehicle	Fjernstyret undervandsfartøj
SBP	Sub-Bottom Profile	
SSS	Sidescan Sonar	Sideseende sonar
VIR	Viking Ship Museum, Roskilde	Vikingskibsmuseet i Roskilde
WGS 84	World geodetic system 1984	

## Project data

The BH2 Sidescan Sonar (SSS) data screening was completed at the Viking Ship Museum in Roskilde, Denmark by maritime archaeologists Marie Jonsson, Torben Malm, Staffan Lundblad and John Howorth.

The entire Energy Island Bornholm project archive is filed at VIR under file no. 2937.

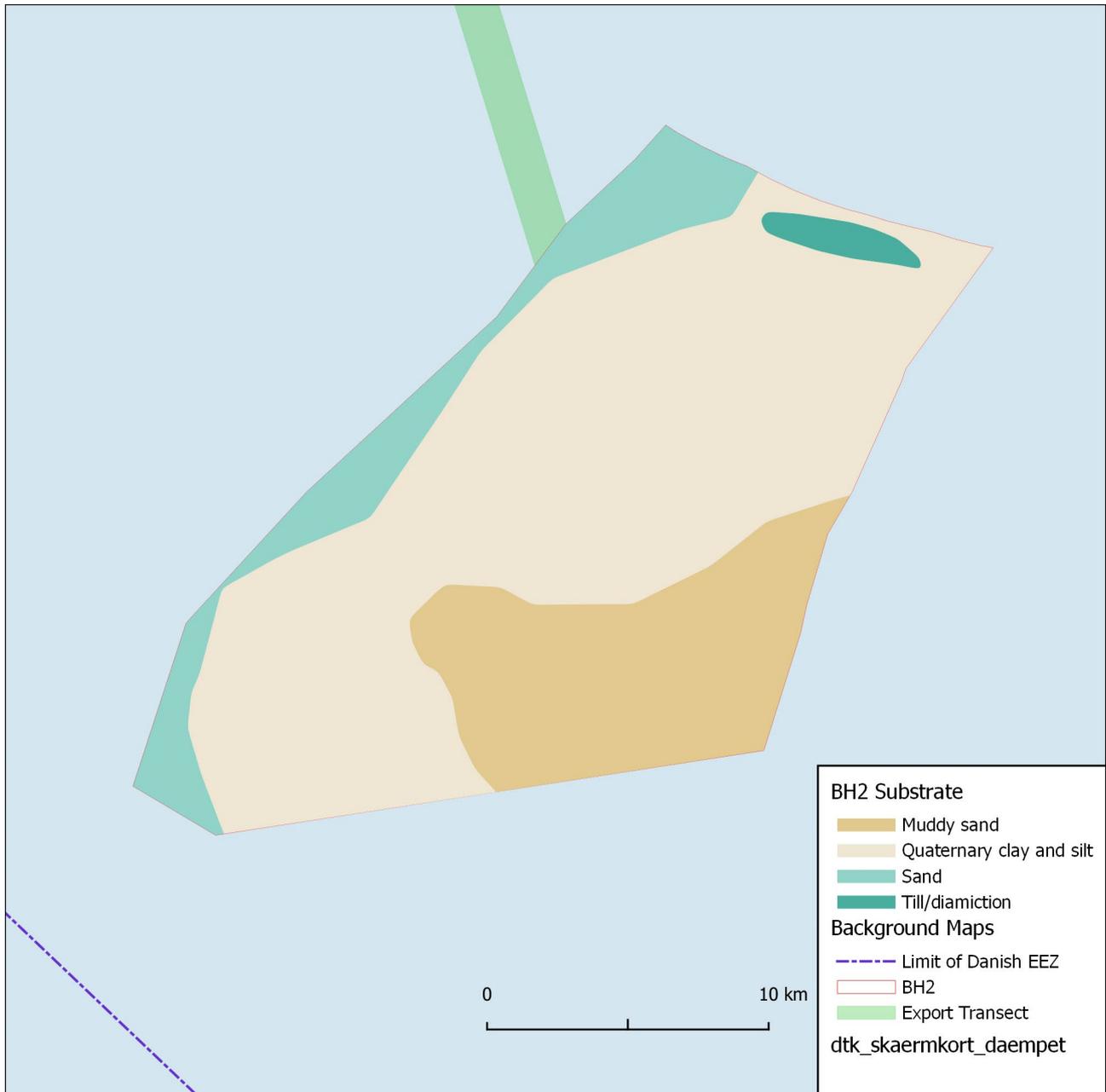
## Topography, terrain and geology

The main part of the eastern wind farm BH2 lies in water over 45 metres deep (GEOxyz, 2023) (Figure 11). A small part of the Rønne Banke crosses into the area on the western edge, here the sea is around 16 metres deep in an area about 200 metres by 1800 metres. The seabed drops abruptly off Rønne Banke down to over 30 metres. The area then generally slopes eastwards down to over 55 metres in the south and west. Towards the north-western edge there is a ridge of slightly shallower water at about 36 metres below sea-level. The seabed substrate is mostly a mixture of clay and silt with some areas of muddy sand to the south east and sand along the western edge. There is a ridge of till/diamiction in the north of the area (Figure 2).

Bornholm is in a part of the Baltic Sea that has been an important and busy shipping channel throughout history, so there is a likelihood of a high number of maritime CHOs in this area.

Parts of the Baltic Sea were dry land during the Mesolithic period. However, even at its lowest level at around 11700 years BP, the water was 40 to 45 metres below current levels meaning that parts of the BH2 area will always have been submerged by the time human habitation began (Jensen &

Bennike, 2021). Most of the rest of the area, between 30 to 40 metres would have only been land for a relatively short period at the beginning of the Mesolithic. The only part of BH2 that remained dry land for a relatively long period is the small area of the Rønne Banke on the very western edge. Sub-bottom profile (SBP) and multibeam echo sounder (MBES) data have been used to study the submerged terrain to identify likely areas for human activity and settlement.



**Figure 2. Map showing seabed substrate in the eastern wind farm area, BH2. Illustration: John Howorth ©Vikingskibsmuseet. Contains data from Styrelsen for Dataforsyning og Effektivisering (dtk\_skaermkort\_daempet) and EMODnet © European Union, 2022. Data collated by GEUS.**

### **Coordinate system**

The present report and associated digital files archived at VIR use the coordinate system: UTM zone 33N, WGS 84, unless otherwise specified.

## Methodology

Using Sonarwiz (v.7.10) software, all High Frequency (HF) SSS data for the BH2 wind farm site was screened and potential archaeological targets were selected based on their shape and size, and the potential for being a CHO. The target was then checked for matching anomalies in other datasets:

- The surveyor’s SSS targets
- The surveyor’s Magnetic (MAG) anomalies
- Danish national registry of CHO finds *Fund og Fortidsminder* (FF) (<https://www.kulturarv.dk/ffreg/>).

Targets were then exported to a mapping project in QGIS (v.3.28.4-Firenze), where further matches were made from the following records:

- Søfartsstyrelsens vragregister – The Danish Maritime Authority’s (DMA) Register for Wrecks.
- *Holddatabasen* – a database from the Agency for Culture and Palaces which contains a list of potential wrecks where the positions have not yet been further investigated.
- *Vragguiden* – Denmark’s largest online wreck database for and by recreational divers.
- Nord Stream 1 and 2 – information from the museum’s archives, VIR 2545 and VIR 2740. Baltic Pipe - information from the museum’s archives, VIR 2813.

Furthermore, extra attention has been paid towards any targets that are found within 500 metres of a registered CHO as they may be related which means that the registration can help identify and/or date the target.

Within this report, references made to objects registered with Fund og Fortidsminder are preceded with FF followed by the unique system number.

## Results

In total there are 1114 targets identified in the SSS data. Each target was assigned a category, a list of the categories used can be seen below. The vast majority of these are so-called *linear objects*. There is a total of 38 wrecks, 11 anchors and 49 mounds, which includes 7 mounds with no height (Figure 3). For more details on locations etc. see appendix 1a-1c.

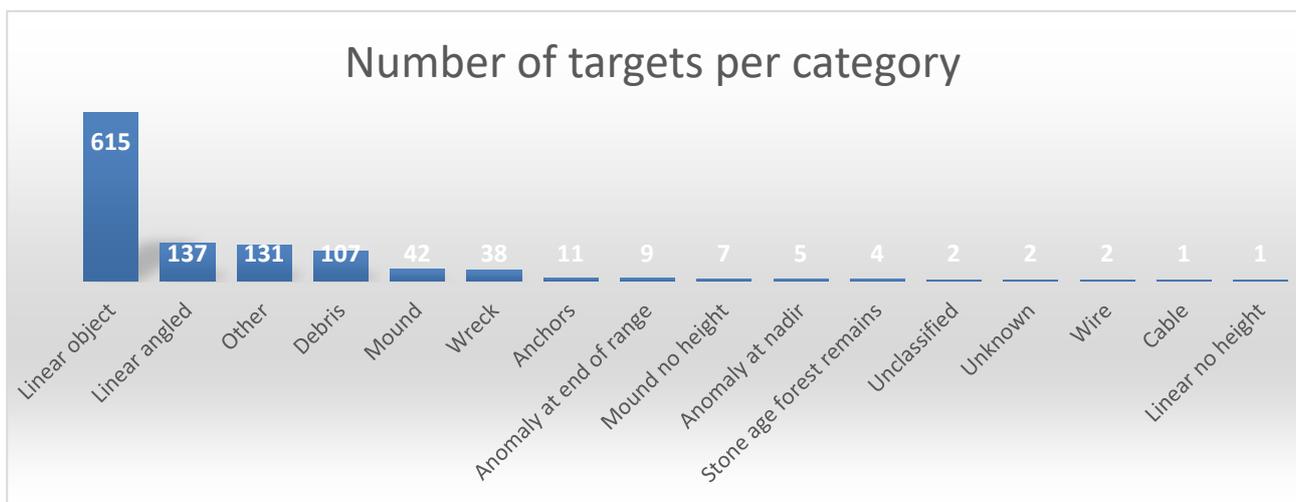


Figure 3. Target categories and number of occurrences.

## List of target categories

Each target category is described below:

<i>Anchor</i>	Anchor/potential anchor
<i>Anomaly at end of range</i>	“Bookmark” for potential object visible in other files/lines
<i>Anomaly at nadir</i>	“Bookmark” for potential object visible in other files/lines
<i>Cable</i>	Cable, chain, etc.
<i>Debris</i>	Manmade object, debris
<i>Hollow contour no height</i>	Ship-shaped object without shadow
<i>Linear object</i>	Linear object of certain size and with shadow
<i>Linear angled</i>	Angled linear object, with or without shadow
<i>Linear no height</i>	Linear object of certain size, without shadow but still noteworthy
<i>Mound</i>	Mound, potentially ballast from broken down wreck
<i>Mound no height</i>	Mound without shadow but still noteworthy
<i>Other</i>	Other type of object. See description
<i>Stone age forest remains</i>	Identified as tree stumps or tree trunks
<i>Unknown</i>	Unknown object of noteworthy size and or shape
<i>Wire</i>	Wire or rope
<i>Wreck</i>	Wreck/potential wreck

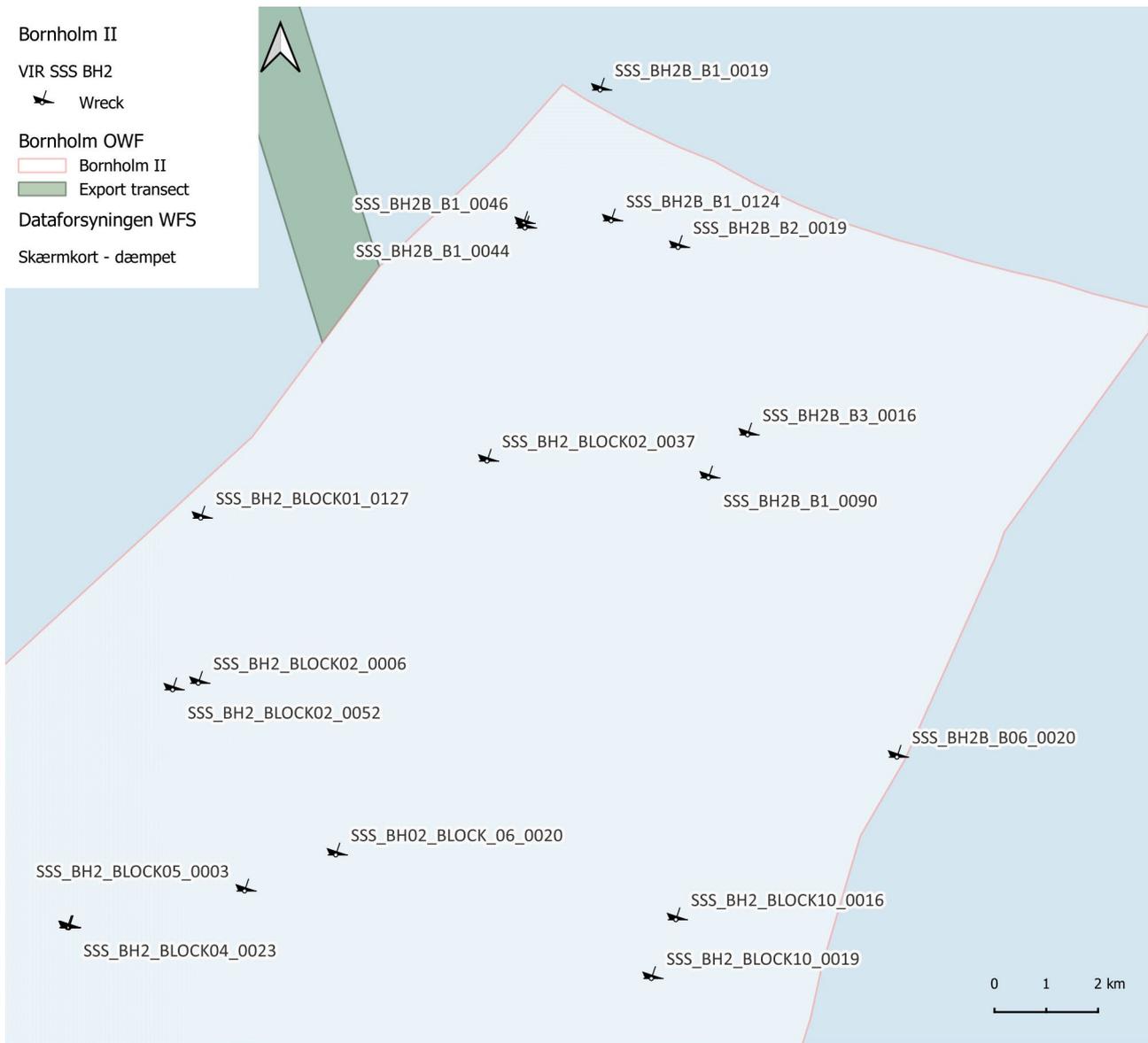
All targets are potentially CHOs. The different linear objects can be wreck parts or cargo. Debris can be remains of cargo or broken up wrecks. Cables is used collectively for cables, wires and ropes, all of which can be part of wrecks or anchors. These categories are not presented in full below in the same manner as wrecks, anchors and mounds, as this would make a too detailed report. However, all targets are covered in Appendix 2, and should be considered as CHOs until investigated. An overview map of all targets identified in the SSS screening can be seen in Appendix 3.

## Wrecks

There are 38 targets categorised as *wrecks* in the SSS data. As well as potential whole wrecks, the targets also represent wreck parts therefore several targets could belong to the same wreck when in close proximity to one another. This is seen in the illustrations below (Figure 4 and Figure 5), where several objects overlap.

One potential wreck, SSS\_BH2B\_B1\_0019, is located about 300 metres to the north of the limit of the wind farm area. There are three objects to the southwest of this possible wreck which are labelled as possible debris; SSS\_BH2B\_B1\_0020 and SSS\_BH2B\_B1\_0027, both described as debris, and SSS\_BH2B\_B1\_0021 is a possible rope. To the south of the wreck is a possible buried object, SSS\_BH2B\_B1\_0032, and there are a further two linear objects to the north, SSS\_BH2B\_B1\_0022 and SSS\_BH2B\_B1\_0092.

In Figure 6 and Figure 7, it can be seen that several potential wrecks correlate with known CHOs from other sources. Three potential wrecks correlate exactly with wrecks registered with *Fund og Fortidsminder*: SSS\_BH02\_BLOCK\_06\_0020 directly correlates with FF 186896; SSS\_BH2B\_B3\_0016 is around 2 metres from FF 195574, a possible clinker-built schooner from the period 1650 to 1750; and SSS\_BH02\_BLOCK\_06\_0022 is around 6 metres from FF 208773, a heavily deteriorated shipwreck.



Contains data from Styrelsen for Dataforsyning og Effektivisering

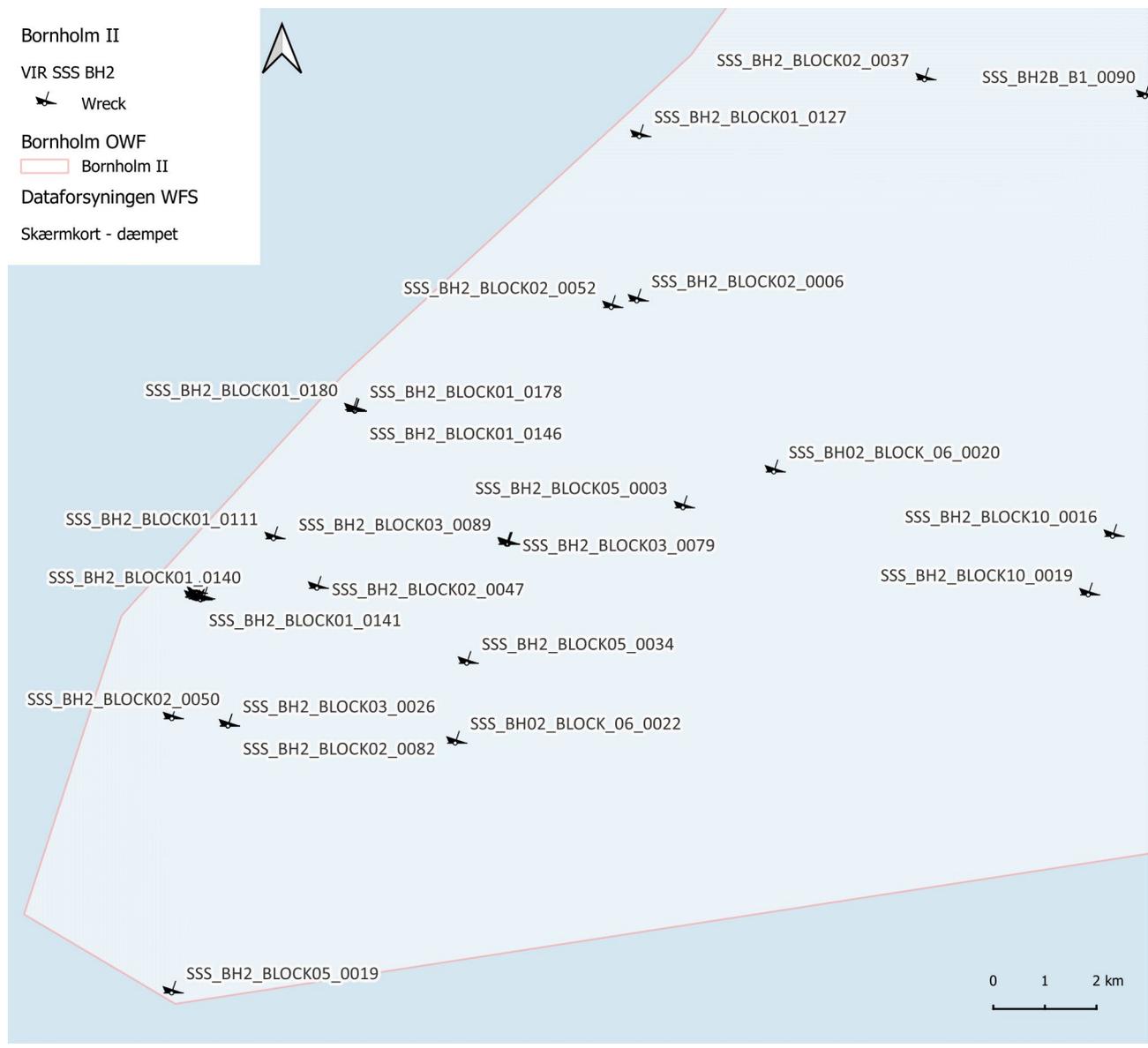
**Figure 4. Overview of the location of possible wrecks in the northern half of BH2. Illustration: John Howorth © Vikingeskibsmuseet. Contains data from Styrelsen for Dataforsyning og Effektivisering.**

Around 100 metres to the southwest of the first *wreck* of the aforementioned group of three, SSS\_BH02\_BLOCK\_06\_0020, is a target described in the survey data as possible wreck debris SSS\_BH02\_BLOCK\_06\_0038. Around 330 metres to the northeast is a mound with linear objects which could also be a possible wreck, SSS\_BH02\_BLOCK\_06\_0041.

Of the other two potential wrecks in the group of three, SSS\_BH2B\_B3\_0016 is surrounded by 8 linear objects, one of which is labelled as parts of the wreck. Whereas the potential wreck labelled SSS\_BH02\_BLOCK\_06\_0022 has only two linear objects nearby, both over 150 metres from the wreck site.

A further potential wreck, SSS\_BH2\_BLOCK10\_0019, is situated around 15 metres from an unnamed ship registered in the DMA's register for wrecks and is potentially related to two objects from *Holddatabasen*, numbers 18525 and 18529. There are four targets categorised as debris within 100 metres on the eastern side, SSS\_BH2\_BLOCK10\_0020 to SSS\_BH2\_BLOCK10\_0023. A

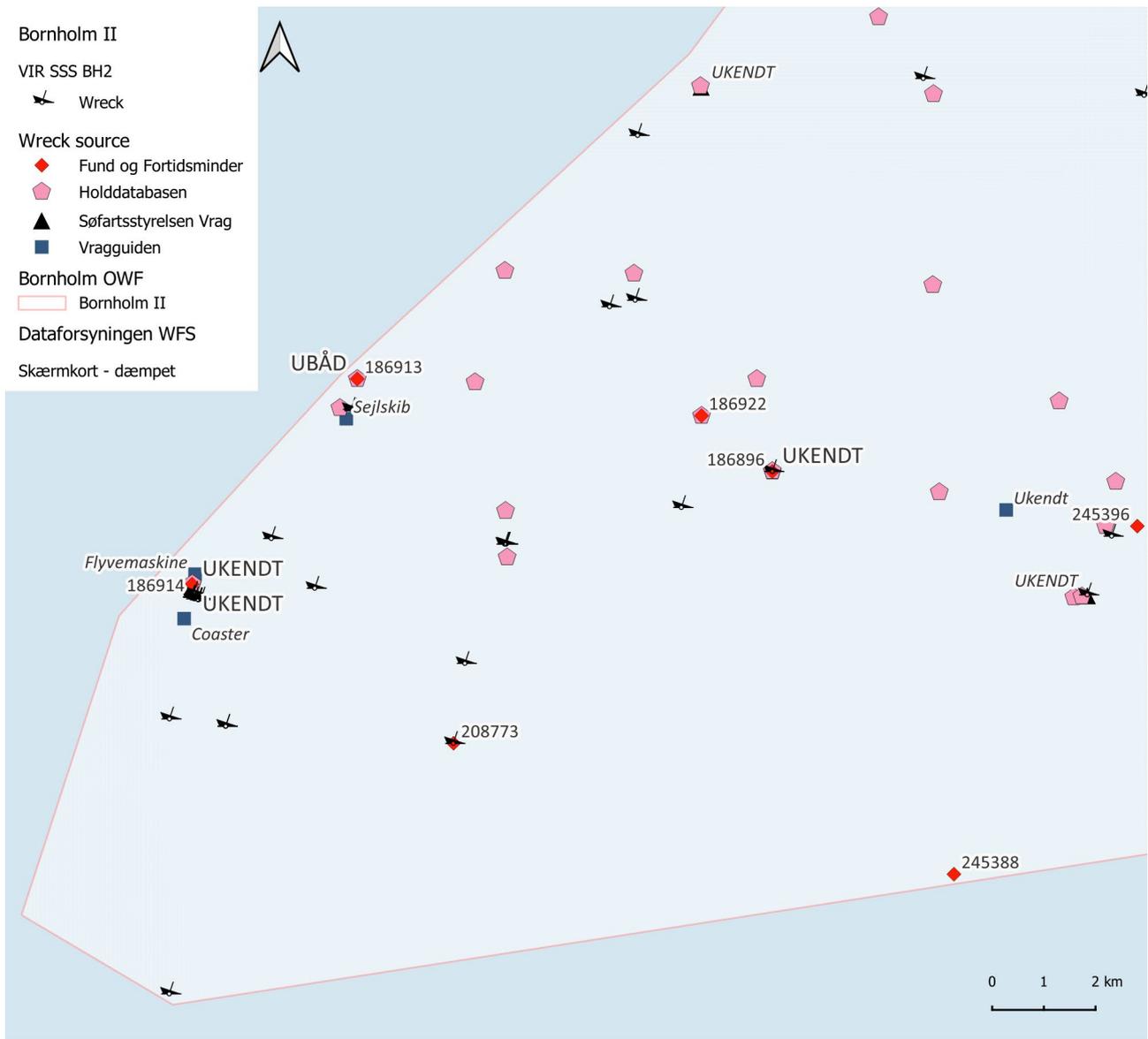
further possible man-made object is located about 350 metres to the northeast, SSS\_BH2\_BLOCK10\_0034.



Contains data from Styrelsen for Dataforsyning og Effektivisering

**Figure 5. Overview of the location of possible wrecks in the southern half of BH2. There are a number of overlapping targets on the western side which are all parts of the same vessel. Illustration: John Howorth © Vikingskibsmuseet.**

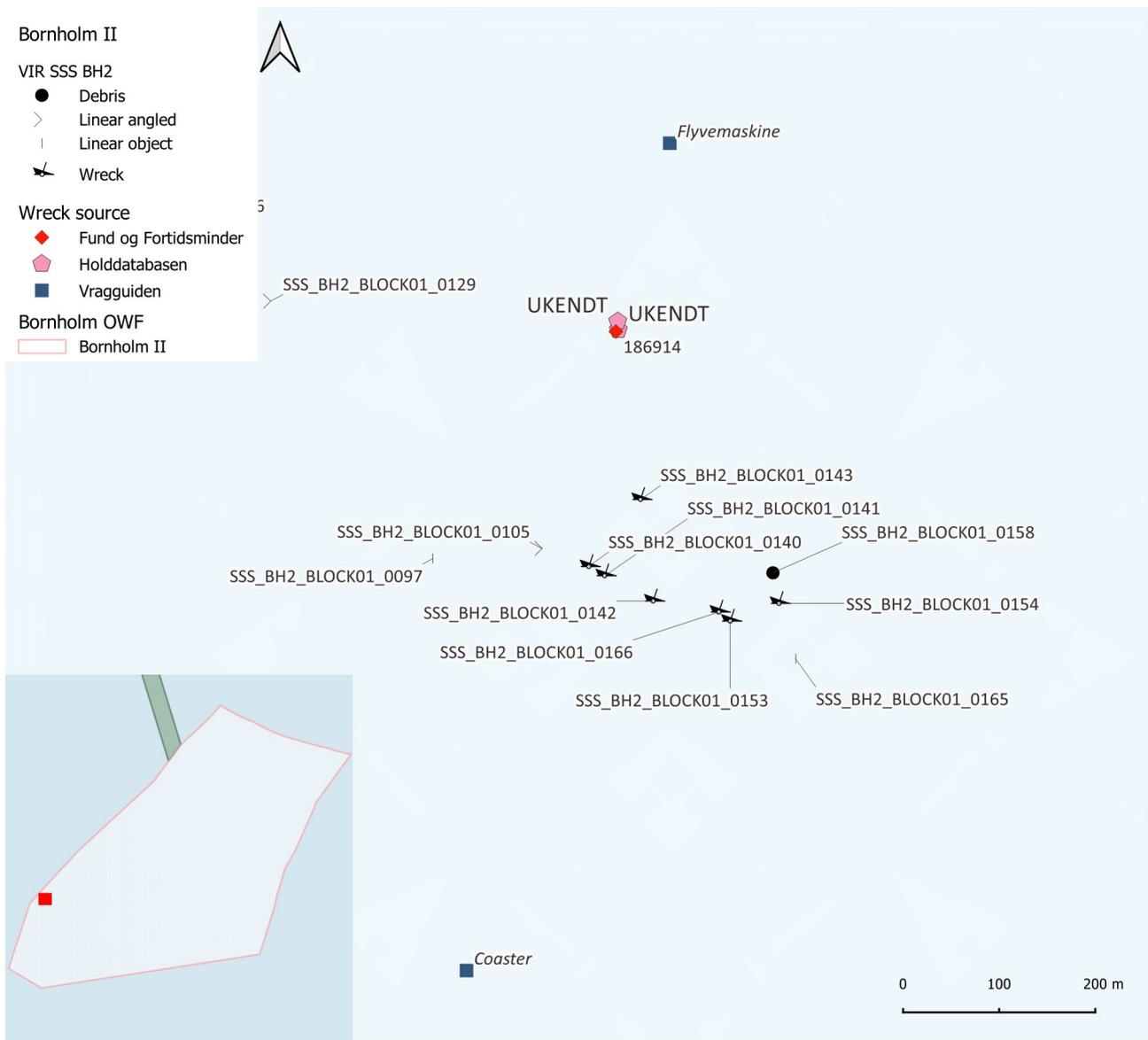




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**Figure 7. Overview of the location of possible wrecks in relation to information from other sources, southern portion of area BH2. Flyvemaskine = Airplane; Sejlskib = Sailing Vessel; Ukendt = Unknown; UBÅD=Submarine. Illustration: John Howorth © Vikingeskibsmuseet.**

Towards the southwestern corner of BH2 there is a cluster of 7 targets all of which are categorised as *wrecks* (Figure 8). SSS\_BH2\_BLOCK01\_0153 is the main part of a shipwreck, with SSS\_BH2\_BLOCK01\_0166 also being part of the main vessel. This wreck could be a coaster mentioned in *Vragguiden*, the geo-object of which is located about 450 metres to the southwest.



**Figure 8.** Close-up of an area with a cluster of seven targets all categorised as *wreck*. All are parts of the same wreck or debris/cargo from the sunken vessel. SSS\_BH2\_BLOCK01\_0153 is the main vessel. This could be the coaster mentioned in *Vragguiden*, the geo-object lies to the south. Illustration: John Howorth © Vikingskibsmuseet.

The remaining 5 targets, SSS\_BH2\_BLOCK01\_0140, SSS\_BH2\_BLOCK01\_0141, SSS\_BH2\_BLOCK01\_0142, SSS\_BH2\_BLOCK01\_0143, and SSS\_BH2\_BLOCK01\_0154, are all debris from the wreck.

In another area, approximately 5 kilometres to the northeast of the above mention cluster, there are three more targets categorised as *wreck* clustered together. SSS\_BH2\_BLOCK01\_0146 is the main part of the wrecked vessel, SSS\_BH2\_BLOCK01\_0178 is another point on same wreck, and SSS\_BH2\_BLOCK01\_0180 is debris. This could be the sailing vessel mentioned in *Vragguiden*, geolocated around 200 metres to the southwest of the targets.

SSS\_BH2\_BLOCK10\_0016, is described as a shipwreck which appears to have been damaged by trawling activity, and to the south and west are three areas of debris, SSS\_BH2\_BLOCK10\_0025, SSS\_BH2\_BLOCK10\_0026, and SSS\_BH2\_BLOCK10\_0038, probably originating from the wreck itself. It is located 500 metres to the southwest of a 7-metre long ship mast registered with *Fund og Fortidsminder*, FF 245396.

**Table 2 List of potential wrecks**

SSS_BH2_BLOCK01_0127	wreck	Debris, or wreck parts consisting of linear object, and poss rope, with loop.
SSS_BH2_BLOCK01_0140	wreck	Same as SSS_B01_0112. Wreckpart from SSS_B01_0104
SSS_BH2_BLOCK01_0141	wreck	Wreck parts from SSS_B01_0104
SSS_BH2_BLOCK01_0142	wreck	Same as SSS_B01_0109. Wreck part from SSS_B01_0109
SSS_BH2_BLOCK01_0143	wreck	Possible wreck debris.(from SSS_B01_0104) Matching MAG anomaly
SSS_BH2_BLOCK01_0146	wreck	Same as SSS_B01_0261. Wreck, partly buried. Some parts seem to be spread out in the area, but otherwise well preserved.
SSS_BH2_BLOCK01_0153	wreck	Same as SSS_B01_0104. Well preserved wreck, but with some parts spread out in the area. Open cargo hatches.
SSS_BH2_BLOCK01_0154	wreck	Same as SSS_B01_0107. Poss wreck parts from SSS_B01_0104
SSS_BH2_BLOCK01_0166	wreck	Just another angle of SSS_B01_0104
SSS_BH2_BLOCK01_0178	wreck	Alternative image.
SSS_BH2_BLOCK01_0180	wreck	Wreck parts from SSS_B01_0261
SSS_BH2_BLOCK01_0111	Wreck	Faint, but, 5-6pcs. 3 meters long linear objects. Ships frames?
SSS_BH2_BLOCK02_0006	Wreck	Same as SSS_B02_0617. Pile of linear objects, pres a wreck. Additional linear objects in the area.
SSS_BH2_BLOCK02_0037	Wreck	Same as SSS_B02_0374. Row of objects. Ships frames?
SSS_BH2_BLOCK02_0047	Wreck	Same as SSS_B02_1112. Poss wreck. Ship shaped anomaly without height
SSS_BH2_BLOCK02_0050	Wreck	Same as SSS_B02_0682. Ship shaped object
SSS_BH2_BLOCK02_0052	Wreck	Area with several short linear objects, plus MAG anomaly
SSS_BH2_BLOCK02_0082	Wreck	Same as SSS_B02_0467. Several short linear objects.Poss wreck.
SSS_BH2_BLOCK03_0026	Wreck	Same as SSS_B02_0468: Pile of linear objects.
SSS_BH2_BLOCK03_0079	Wreck	Same as SSS_B03_10793. Well preserved wreck with debris field around. Corresponding MAG anomaly.
SSS_BH2_BLOCK03_0089	Wreck	Wreck debris 15 m east of SSS_BH2_BLOCK03_0079
SSS_BH2_BLOCK10_0016	Wreck	Shipwreck that seems to be demolished by trawling indicated by disturbed seabed in vicinity. Same as SSS_BHII_B10_0101
SSS_BH2_BLOCK10_0019	Wreck	Shipwreck with scattered debris around. Disturbed seabed in vicinity indicating damage by trawling. Same as SSS_BHII_B10_0094
SSS_BH2_BLOCK04_0023	Wreck	Same as SSS_B04_100001. Well preserved wresk, also caputered in Block 3 SSS. Pres sailing vessel, as a mast like objet is lying to the south of the wreck. Another two spars are located in either end of the wreck. There is also some rope, to the sout
SSS_BH2_BLOCK04_0027	Wreck	Circular feature on the wreck, rising higher than the wreck.
SSS_BH2_BLOCK05_0003	Wreck	Same as SSS_B05_11483. Poss wreck, or container. Matching MAG anomaly
SSS_BH2_BLOCK05_0019	Wreck	Area with a large number of linear objects next to trawl/anchor track. Poss wreck parts
SSS_BH2_BLOCK05_0034	Wreck	Same as SSS_B05_10455. A pile of linaer objects, pres wreck. A 15 m long object is lying NE of the pile, pres mast. MAG anomaly only in geoTIFF.

SSS_BH02_BLOCK_06_0020	Wreck	Known wreck, system number 186896 in FF
SSS_BH02_BLOCK_06_0022	Wreck	Same as SSS_B06_0345. FoF syst nr 208773. Wreck, identified during Nordstream 1 SSS/ROV campaign. Situated in depression, no construction elements visible in current SSS image, only light bottom.
SSS_BH2B_B1_0019	Wreck	Small wreck. Check other SSS file for better image (VIR0026). Debris scattered around. Registered in navigation charts, just outside the park area.
SSS_BH2B_B1_0044	Wreck	Scattered, broken down wreck, parts up to 100 meters away. High possibility for objects buried in the sediment. Pres old, judging from the state of degradation.
SSS_BH2B_B1_0046	Wreck	Same as BH2B_B1_0772. Poss part from VIR0044
SSS_BH2B_B1_0090	Wreck	Poss wreck. Linear objects lying in a ships frames fashion. Pres most of it is buried.
SSS_BH2B_B1_0124	Wreck	Same as BH2B_B1_1079, among others. Corresponding MAG anomaly. Rows of protruding small objects. Poss buried shipwreck.
SSS_BH2B_B2_0019	Wreck	Timber shipwreck with surrounding debris field. Within SSS_BH2B_B2_Feature0001 and same as BH2B_B2_5002.
SSS_BH2B_B3_0016	Wreck	Same as BH2B_B3_3040. Wreck with scattered parts over the surrounding area. Known from NordStream project.
SSS_BH2B_B06_0020	Wreck	Same as BH2B_B6_0056. Large debris field with various concave and linear objects, possible shipwreck site.

Targets, SSS\_BH2\_BLOCK03\_0079, SSS\_BH2\_BLOCK03\_0089, SSS\_BH2\_BLOCK04\_0023, and SSS\_BH2\_BLOCK04\_0027 are potentially all from the same wreck and lie in a line from east to west for about 30 metres. They lie approximately 250 metres north of an entry into *Holddatabasen*, number 3315. The wreck parts are surrounded by debris and linear objects which are mainly concentrated within 150 metres to the east and west. To the east the debris consists of some lengths of rope or cable which could be ship rigging, but also potentially fishing gear caught on the wreck parts.

SSS\_BH2\_BLOCK02\_0037 is a row of objects, possible ship frames, which are located around 500 metres to the southeast of two possible anchors, SSS\_BH2B\_B2\_0036 and SSS\_BH2B\_B2\_0037. There are seven linear objects and an S-shaped object scattered within 500 metres around the wreck site, none of them have been described as being possible wreck pieces or debris, but this cannot be ruled out.

At the very eastern extent of BH2 is SSS\_BH2B\_B06\_0020. There are almost no CHOs situated close to this target. There is a location for an entry into *Holddatabasen*, number 18526, situated 450 metres to the west. A mound, SSS\_BH2B\_B1\_0091, described as a ballast mound, and a possible area of debris, SSS\_BH2B\_B2\_0107, are in the same location and are probably part of the same feature seen on different scans.

The following targets do not sit in close proximity to any previously known CHOs or objects registered with *Vragguiden*, *Holddatabasen* or *Fund of Fortidsminder*. Some have a few *linear objects* or *debris* nearby but, apart from these, there is no indication of their age or significance. Only a visual investigation with an ROV will resolve this. It is necessary to keep in mind that all the targets have potential to be a CHO despite their proximity to previously known sites.

SSS\_BH2B\_B2\_0019 is a broken up wooden wreck surrounded by debris scattered over an area covering c. 2000 m<sup>2</sup>. A further ten linear objects lie within a 500-metre radius, mostly to the west

and all are possibly related to this wreck. An unusual shaped feature, SSS\_BH2B\_B2\_0054, is situated about 350 metres to the southeast which could also be related.

SSS\_BH2\_BLOCK01\_0111 described in the SSS data as faint but consisting of 5 or 6 linear objects each approximately 3 metres long, possibly the frame of a vessel.

SSS\_BH2\_BLOCK02\_0047 is a ship-shaped anomaly.

SSS\_BH2\_BLOCK02\_0006 and SSS\_BH2\_BLOCK02\_0052 lie approximately 500 metres apart and both described as a pile of linear objects. Two *linear objects* close to SSS\_BH2\_BLOCK02\_0006 are described as being parts of the wreck. There is one *linear object* in very close proximity to SSS\_BH2\_BLOCK02\_0052 which may also be a part of this wreck.

SSS\_BH2B\_B1\_0044 and SSS\_BH2B\_B1\_0046 lie less than 100 metres apart and are likely to be parts of the same wreck which is described in the SSS data as being very degraded. A linear object lies between the two main wreck areas, SSS\_BH2B\_B1\_0045, and is also described a wreck part.

There are three potential wrecks towards the southwestern corner of the area:

SSS\_BH2\_BLOCK02\_0082; SSS\_BH2\_BLOCK03\_0026; and SSS\_BH2\_BLOCK02\_0050. The first two are both described as a collection of a number of linear objects, and only 4 metres apart so are likely to be related. The third, SSS\_BH2\_BLOCK02\_0050, is described as a ship shaped object and situated around a kilometre to the west of the two aforementioned potential *wrecks*. There are very few other objects spotted within 500 metres.

SSS\_BH2\_BLOCK05\_0003 is described as a wreck or container and correlates with a MAG anomaly with the target ID of BHII\_MAG\_1780.

SSS\_BH2\_BLOCK05\_0019 is found at the very southern limit of the wind farm area and is described as a large number of linear objects which are scattered over an area of about 50 metres by 20 metres. 300 metres to the west of this area, there is another area of linear objects, SSS\_BH2\_BLOCK05\_0051.

Another seemingly isolated potential wreck is SSS\_BH2\_BLOCK05\_0034, described as pile of linear objects with a potential mast towards the northeast. Immediately to the southeast, there is a linear object that is possibly linked to the *wreck*.

SSS\_BH2B\_B1\_0090 is another isolated target and is probably the same as SSS\_BH2B\_B06\_0057, both are described as a collection of linear objects.

SSS\_BH2\_BLOCK01\_0127 is described in the SSS data as debris, or wreck parts consisting of a *linear object*, and possible rope with a loop. It is possibly related to SSS\_BH2\_BLOCK01\_0076, a *linear object* just over 100 metres to the northeast. This target is also located approximately 370 metres to the northwest of a possible ballast mound, SSS\_BH2\_BLOCK01\_0094, and therefore both of these could be parts of a wreck that have drifted apart.

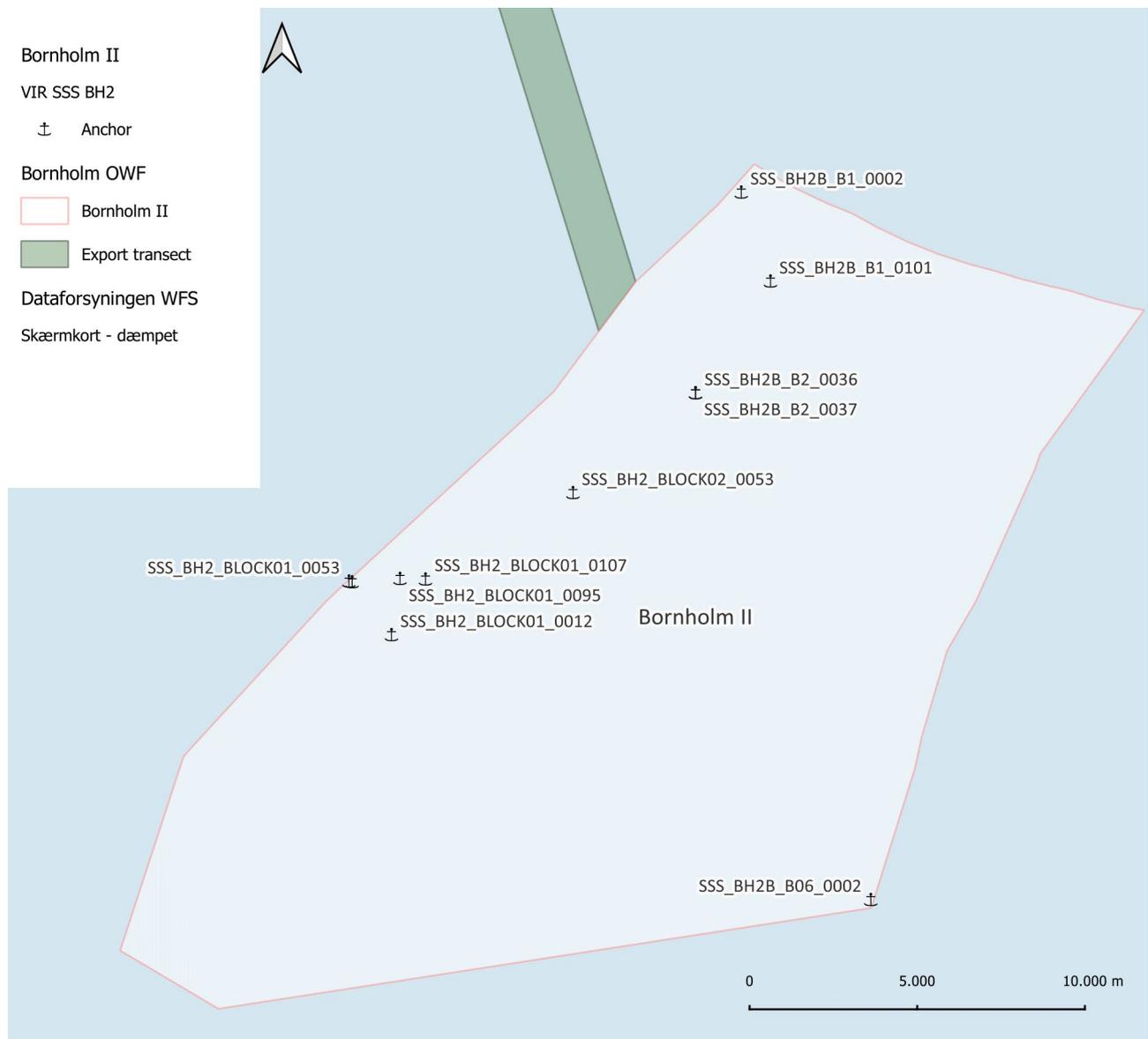
Finally, SSS\_BH2B\_B1\_0124 is possible buried shipwreck according to description in the SSS data.

## **Anchors**

Eleven possible anchors have been identified in the SSS data. None of these lie within 500 metres of any previously known CHO. Two anchors, SSS\_BH2B\_B2\_0036 and SSS\_BH2B\_B2\_0037, were spotted relatively close to a possible wreck and have been discussed in the “Wreck” portion of this report.

SSS\_BH2B\_B1\_0002 in the north-western corner is surrounded by 12 targets categorised as *linear objects* or *debris*. These could be indications of a wreck or parts of a wreck in the area.

SSS\_BH2B\_B06\_0002 is located in the very south-eastern corner of BH2. There are no nearby CHOs but there appears to be a trail of debris running towards the southwest from this possible anchor.



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**Figure 9 Overview of the location of possible anchors. Illustration: Marie Jonsson © Vikingskibsmuseet. Contains data from Styrelsen for Dataforsyning og Effektivisering**

SSS\_BH2\_BLOCK01\_0053 and SSS\_BH2\_BLOCK01\_0058 are two possible anchors situated about 100 metres apart with no other targets or CHOs in the near vicinity.

SSS\_BH2\_BLOCK01\_0095 lies approximately 360 metres from two mounds SSS\_BH2\_BLOCK01\_0087 and SSS\_BH2\_BLOCK01\_0093.

SSS\_BH2\_BLOCK01\_0107, SSS\_BH2\_BLOCK02\_0053, SSS\_BH2B\_B1\_0101 are all possible anchors which do not lie close to any other targets or CHOs.

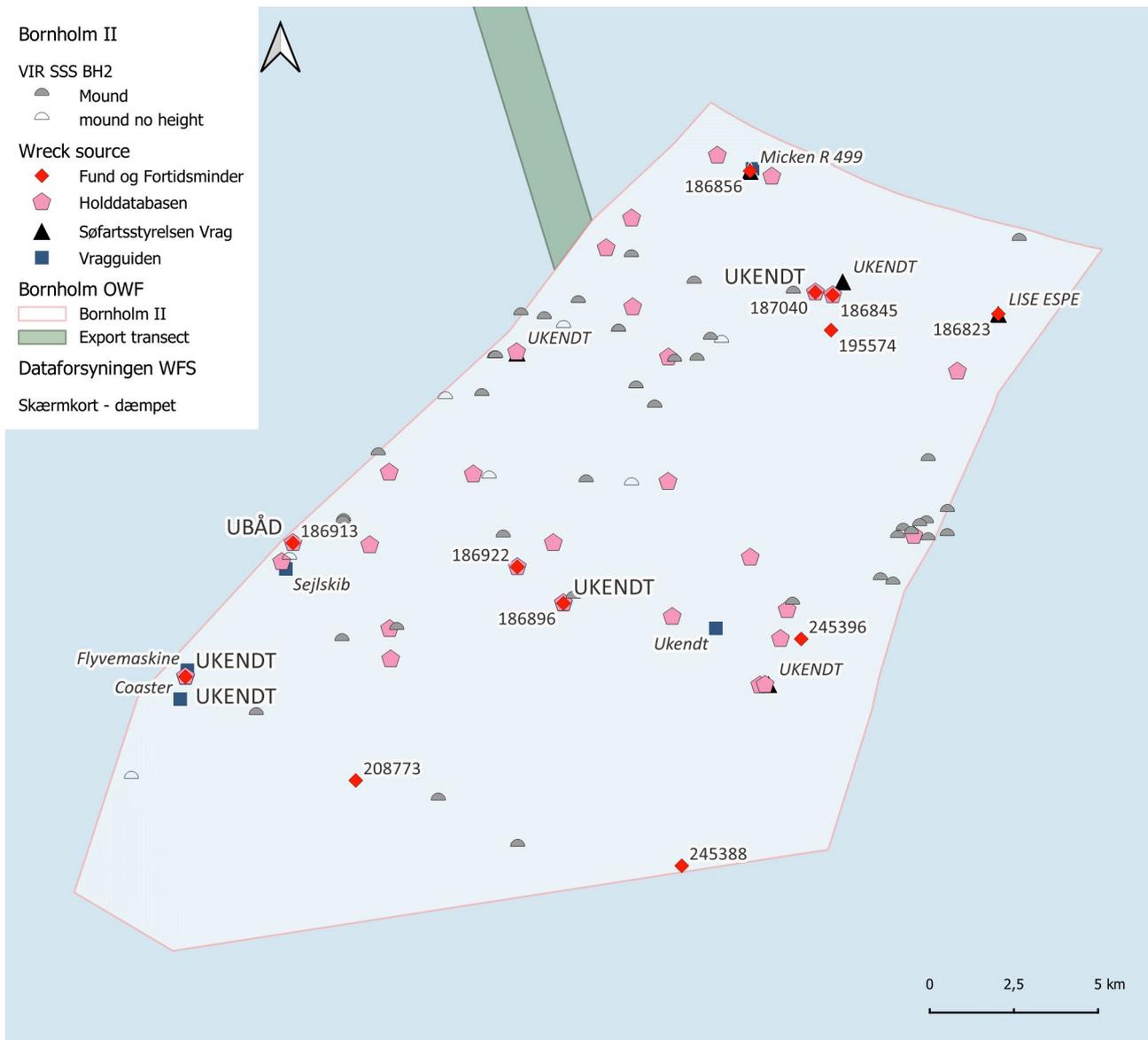
**Table 3 List of Anchors**

SSS_BH2_BLOCK01_0012	Anchor	Strange shadow, seemingly high object
SSS_BH2_BLOCK01_0053	Anchor	Poss anchor.
SSS_BH2_BLOCK01_0058	Anchor	Small object with strange shadow. Poss anchor
SSS_BH2_BLOCK01_0095	Anchor	Same as SSS_B01_0720. Poss anchor
SSS_BH2_BLOCK01_0107	Anchor	Anchor at end of cable?
SSS_BH2_BLOCK02_0053	Anchor	Same as SSS_B02_0174. Linear angled. Matching MAG anomaly. Poss anchor
SSS_BH2B_B1_0002	Anchor	Same as BH2B_B1_0813. Pres MMO. Anchor looking, check for MAG in future
SSS_BH2B_B1_0101	Anchor	Same as BH2B_B1_0987. Corresponding MAG anomaly. Angled linear object, poss anchor
SSS_BH2B_B2_0036	Anchor	Large irregular shaped object, probably manmade, possibly an anchor, situated close to SSS_BH2B_B2_0037. Possibly the same as BH2B_B2_0214.
SSS_BH2B_B2_0037	Anchor	Possibly the shank of an anchor in close proximity and probably related to SSS_BH2B_B2_0036.
SSS_BH2B_B06_0002	Anchor	Same as MMO_PTS_0354

## Mounds

There is a total of 42 *mounds* and a further 7 targets classed as *mound-no-height* (Figure 10). 19 *mounds* and 2 *mound-no-height* have specifically been described as ballast mounds in the SSS data.

Three of the *mounds* and two *mound-no-height* have also been described as possible wrecks, there is some overlap with those described as ballast mounds. SSS\_BH2\_BLOCK09\_0029 and SSS\_BH2B\_B1\_0091 are both described as ballast mounds and possible wrecks. The *mound-no-height* described as a possible wreck and ballast is SSS\_BH2\_BLOCK01\_0116. SSS\_BH02\_BLOCK\_06\_0041 and SSS\_BH2B\_B1\_0121 are the *mound* and *mound-no-height* respectively that have only been described as possible wrecks. The former was mentioned earlier in the “Wreck” portion of this report.



Contains data from Styrelsen for Dataforsyning og Effektivisering

**Figure 10. Overview of the location of mounds in relation to information from other sources. Illustration: John Howorth © Vikingskibsmuseet.**

Some of the mounds that correlate with possible wrecks and other sources have already been described above. The vast majority of the remaining mounds are not in close proximity to any entries into *Fund of Fortidsminder*, *Holdddatabasen*, *Vragguiden* or DMA's Register for Wrecks. Below is a description of the mounds which do.

SSS\_BH2\_BLOCK03\_0007, described as a possible ballast mound, is situated approximately 230 metres from an object registered in *Holdddatabasen*, number 18509. Another possible ballast mound, SSS\_BH2\_BLOCK03\_0048, is located at around 230 metres from object number 18502 from *Holdddatabasen*.

SSS\_BH2B\_B06\_0017 lies just under 100 metres from an object in *Holdddatabasen*, number 18526, and is described as a circular mound. There are a further four mounds within 500 metres of the same CHO, these are: SSS\_BH2B\_B06\_0013, a small mound or rock; SSS\_BH2B\_B06\_0015, two small mounds close to one another; SSS\_BH2B\_B06\_0100, a possible oval mound; and SSS\_BH2B\_B1\_0091, which has been mentioned above as a possible wreck. There are several

linear objects and unidentified “other” objects scattered throughout this area, these could be debris from wrecks or possible objects that have been trapped among the mounds and natural terrain.

A mound with no height, SSS\_BH2\_BLOCK02\_0005 is found within 500 metres of an entry into *Holddatabasen*, number 18504.

A second mound with no height is located in between a couple of registered wrecks.

SSS\_BH2\_BLOCK01\_0071 is between FF 186913, described as a 1940s fishing vessel and a sailing vessel described in The DMA’s Register for Wrecks. Close to this mound with no height, are two linear objects described as possible wreck parts. Further possible wreck debris, SSS\_BH2\_BLOCK01\_0035 and SSS\_BH2\_BLOCK01\_0084, and an unusual L-shaped feature are situated near the 1940’s wreck, FF 186913. Whereas SSS\_BH2\_BLOCK01\_0072, described as a spar, mast or pole, is found 220 metres to the north of the potential wreck mentioned in *Vragguiden*.

SSS\_BH2\_BLOCK09\_0023 is another mound described as a possible ballast mound and found close to 18527 in *Holddatabasen*. Approximately 200 metres to the north of this mound, there are two objects, one is labelled as a possible anchor and the other as likely debris, both of these could be related to the mound and the object from *Holddatabasen*.

### **Aircraft**

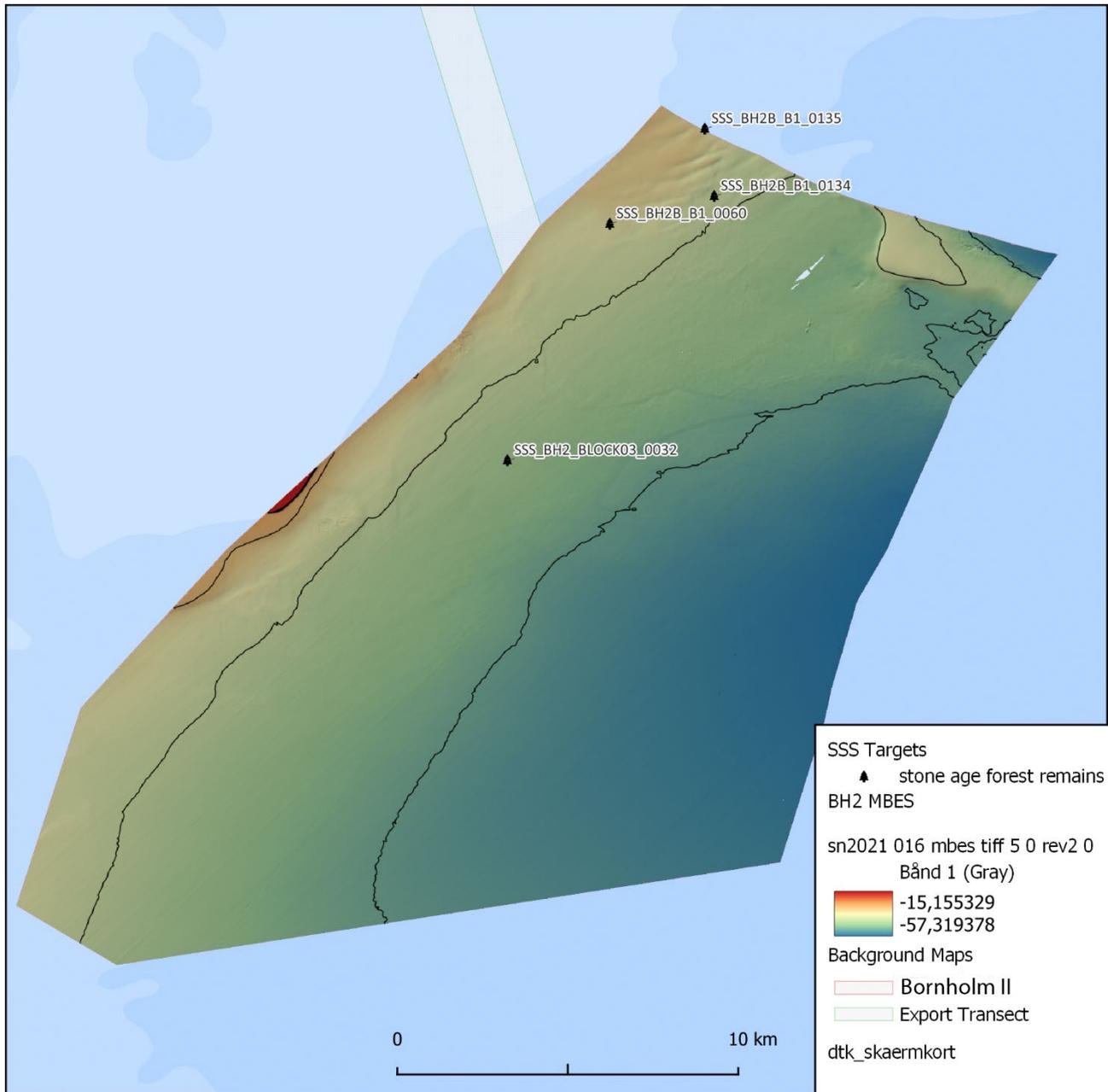
Towards the southwestern area of BH2 there is a registered sunken WWII aircraft. It is recorded in the *Fund og Fortidsminder* register, *Holddatabasen* and *Vragguiden*. Despite this, there was no definitive aircraft identified in the SSS data. SSS\_BH2\_BLOCK01\_0105, is the closest identified object and is described as possible disturbance or several linear objects approximately 250 metres to the south of the registered position. There is also a cluster of MAG anomalies and MMOs approximately 300 metres to the south of the possible location of the aircraft. There is the possibility that the aircraft is still in this area but for some reason has not shown up in the SSS data.

### **Stone-Age Potential**

Most of BH2 lies in water that is over 40 metres deep. The latest low-stand water period occurred approximately 11700 years BP when water levels were between 40 to 45 metres below the current levels (Jensen & Bennike, 2021). Therefore, anything around this depth and below are very unlikely to contain any evidence for human activity from the Mesolithic period. The water level then rose relatively quickly. The sub-bottom profile data shows a seabed mainly made up of lake sediments (GEOxyz, 2023), there does not appear to be thick deposits of peat or other heavily organic layers that would suggest a preserved Mesolithic land surface. The most likely areas to find evidence for Mesolithic human activity are on the edge of Rønne Banke which crosses into BH2 in the west and shows up in red in Figure 11. The shallower areas along the western edge, just below Rønne Banke may contain some preserved material washed down from the shallower waters. Areas of gravel and coarse sand are the type of sediments which could hold evidence for prehistoric human activity.

There are four objects categorised as possible stone-age forest remains within VIR’s SSS data (Figure 11). SSS\_BH2\_BLOCK03\_0032 is situated about halfway across BH2, approximately 4 kilometres from the western edge in water over 40 metres deep. The other three, SSS\_BH2B\_B1\_0060, SSS\_BH2B\_B1\_0134, and SSS\_BH2B\_B1\_0135 are in the northwest corner in slightly shallower water but still around 35 to 38 metres deep. During the Baltic Pipe project, prehistoric forest remains were identified on the Rønne Banke with several uprooted trunks found in deeper waters just off the ridge (Jonsson & H. Thomsen, 2022). If these targets are indeed prehistoric tree trunks, they are likely to be fallen trees that have washed into the deeper water rather than rooted forest remains. There is also a possibility that some of the other linear objects in BH2 could also be the remains of trees but this will not be known until they have been investigated visually.

In conclusion, the most likely places to find evidence for Mesolithic human activity in BH2 is along the western edge on, and immediately below, Rønne Bank in areas of gravel and coarse sand. The potential tree remains could be evidence of a submerged forest which would increase the likelihood of finding organic sediments and human activity, although they are more likely to be uprooted trees such as those found in the Baltic Pipe project (Jonsson & H. Thomsen, 2022). The deeper areas to the south and east are likely to have either always been below water level or were only dry land for a relatively short period of time and are therefore unlikely to contain human settlement.



**Figure 11** Location of possible prehistoric forest remains over contoured MBES data. The contour lines are at 10 metre intervals with the shallowest at 20 metres and the deepest at 50 metres. MBES data provided by GEOxyz. Illustration: John Howorth © Vikingskibsmuseet. Contains data from Styrelsen for Dataforsyning og Effektivisering (dtk\_skaermkort).

## **Future work**

Within the current BH2 area (OWF\_Bornholm\_3GW), all the SSS targets from the separate survey blocks have been merged into a single GIS file:

*VIR\_SSS\_BH2*

The GIS file corresponds to Appendix 2 in this report.

In previous projects, it was common practice to create so-called first-generation exclusion zones around potential CHOs depending on the nature and size of the object. An assessment was then made on whether these zones intersected the future work areas. The targets with buffer zones which intersected the work areas were then more closely studied in the side scan and multibeam sonar and the buffer zone was reassessed based on the type, shape, and extent of object. However, more recent guidelines from the Danish Agency for Culture and Palaces urge against the use of these preliminary exclusion zones before visual inspection (Appendix 4).

All targets which are within, and in close proximity to, the proposed work areas should be visually inspected by ROV and the footage screened by archaeologists from VIR in order to further assess their significance. Targets which, through this process, are positively identified as CHOs, will be reported to the National Sites and Monuments register (*Fund og Fortidsminder*). A definitive exclusion zone can then be created around any protected archaeological objects.

The same goes for potential stone age sites, an initial area along the western side has been highlighted, but in order to conclude any positively identified sites, further investigation is needed. Such investigations could include dive and/or machine test pit excavations.

If the client's work cannot be carried out due to an exclusion zone or altered to avoid it, special dispensation can be sought. This dispensation would typically state that a marine archaeological survey or excavation would need to be carried out on the site.

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