

Marine data acquisition for Palaeolandscape reconstruction at the World Heritage Sites, Orkney  
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## **1.0 Introduction and Aims of the survey**

The island of Orkney contains some of Scotland's most important archaeological sites within the World Heritage Neolithic Monument Envelope. While much is known about the sites little is understood about the landscape context within which they sit or what the environment was like when they were built and used. A major reason for this is that the landscapes have changed significantly over the millennia with large land areas flooded by rising sea levels since last Glacial Maximum. This situation is common around the coast of Scotland, where areas that once were land are now lost. To understand the lost landscapes requires mapping of the drowned landscapes using geophysical methods combined with ground truth information from cores and photographic observations.

The aim of this project was to test new technology in the form of the GAVIA Autonomous Underwater Vehicle (AUV) as a technique for rapidly mapping inundated areas of shelf around the UK in order to provide important information for archaeological research.

## **2.0 Background**

The principal objective of this proposal was to test new methods for mapping the seafloor that could provide significant information for palaeo-geographic reconstructions and with archaeological investigations. Traditionally, this form of geophysical mapping has been undertaken using a vessel either customised for survey or adapted with geophysical instruments. Surface vessels however are prone to operation only from safe harbours and are weather contingent as to their operation. Furthermore, many of the areas of greatest interest are characterised by very shallow water with numerous navigation hazards. A new generation of mapping platforms is now available in the form of AUVs fitted with multibeam sonar. Prior to this project these have not been tested for archaeological survey in the very shallow waters of Scotland. This project tested the Gavia AUV fitted with a 500 kHz Geoswath bathymetric mapping system to acquire geophysical (bathymetry, side-scan sonar and seabed images) data over a number of known archaeological sites and also to map seafloor near the iconic sites of the Ring of Brodgar within the shallow lochs of Harray and Stenness and in the Bay of Firth.

The outputs of the project including bathymetry and backscatter data used to construct palaeo-landscapes and the Grasshopper colour seabed camera used to produce photomosaics of the seabed were compared with previously acquired information from geophysical survey and diver survey.

The project has relevance to MASTS in that all of the Scottish coastline has a flooding history where land has been lost. Assessing the viability of the AUV as a mapping tool will benefit not only the TPS forum but also the Coastal Zone Forum, the Coastal Processes and Dynamics Forum and Marine Planning Forum. Further it will provide information of use to government bodies including Historic Environment Scotland.

### **3.0 Methodology**

The AUV was deployed in two different locations, namely the fresh water loch of Harray to the east of the Ring of Brodgar and in the Bay of Firth to the south of Damsay west of Finstown (figure 1). At the loch of Harry the AUV was launched from the shore and monitored using a small rib inflatable (figure 2). South of Damsay the AUV was transported to the site via a small inflatable rib from which it was launched and recovered. Each survey was accomplished in a single acquisition period between 24-26 May, 2016.

### **4.0 Results**

#### ***Loch of Harray***

Deployment in the loch of Harray proved problematic due to the shallow water depth and the very low salinity. Modifications were necessary to the AUV to prevent the buoyancy control forcing the AUV to dive beneath the surface and into the seafloor. The resulting mosaic of seafloor imagery was disappointing because of the shallow water limiting the range of the sonar and the relatively noisy data because of buoyancy control issues. For this reason only individual lines were analysed from the data set. The track plan of line acquisition is shown in figure 3.

#### ***Bay of Firth***

The depth range in the Bay of Firth at 7-9m was sufficient to obtain a reasonable dataset for the site without any modifications to the AUV for buoyancy control. Sidescan and bathymetry data was obtained that demonstrated the very high resolution of the sonar. In addition a series of images was also obtained from the Grasshopper camera. Sidescan results are shown in figure 4 and bathymetry in figure 5. An example of the camera records is shown in figure 6.

### **5.0 Discussion**

The AUV provided very high resolution bathymetry and sidescan sonar information that is of high relevance to archaeological site prospection and characterisation. In water depths over 5m this data was acquired with the AUV operating with standard protocols and thus data acquisition was fast and efficient. Deployment of the sonar was easy from both boats and the shore line thus eliminating the need for bespoke survey vessels. It was also noted that preliminary data processing can be achieved relatively quickly on completion of missions. The relatively high cost of an AUV is to some extent balanced against the quantity of high quality data that it is possible to obtain with the survey platform. The use of AUVs is thus an important addition to the arsenal of techniques for marine archaeological investigation.

Figure 1 – Location of Loch of Harry to the north of Stenness and Bay of Firth to the east of Finstown

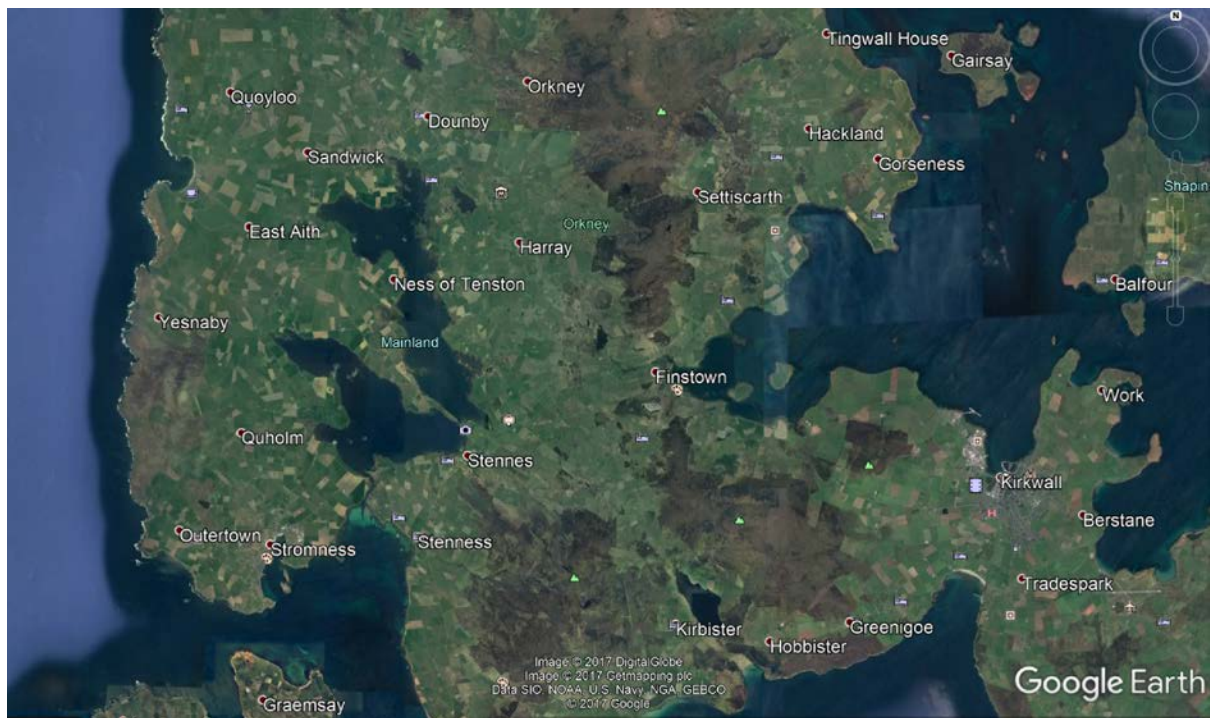


Figure 2 – Gavia AUV launch at Loch of Harry



Figure 3 – line plan for Loch of Harry

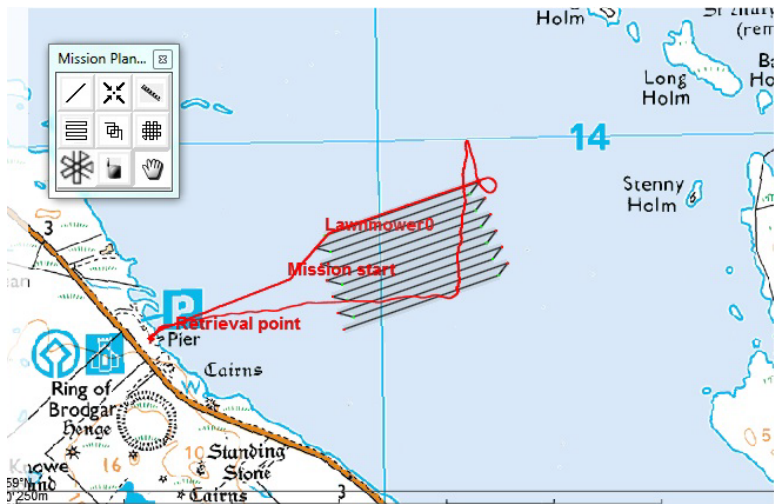


Figure 4 – Sidescan sonar mosaic for Bay of Firth site

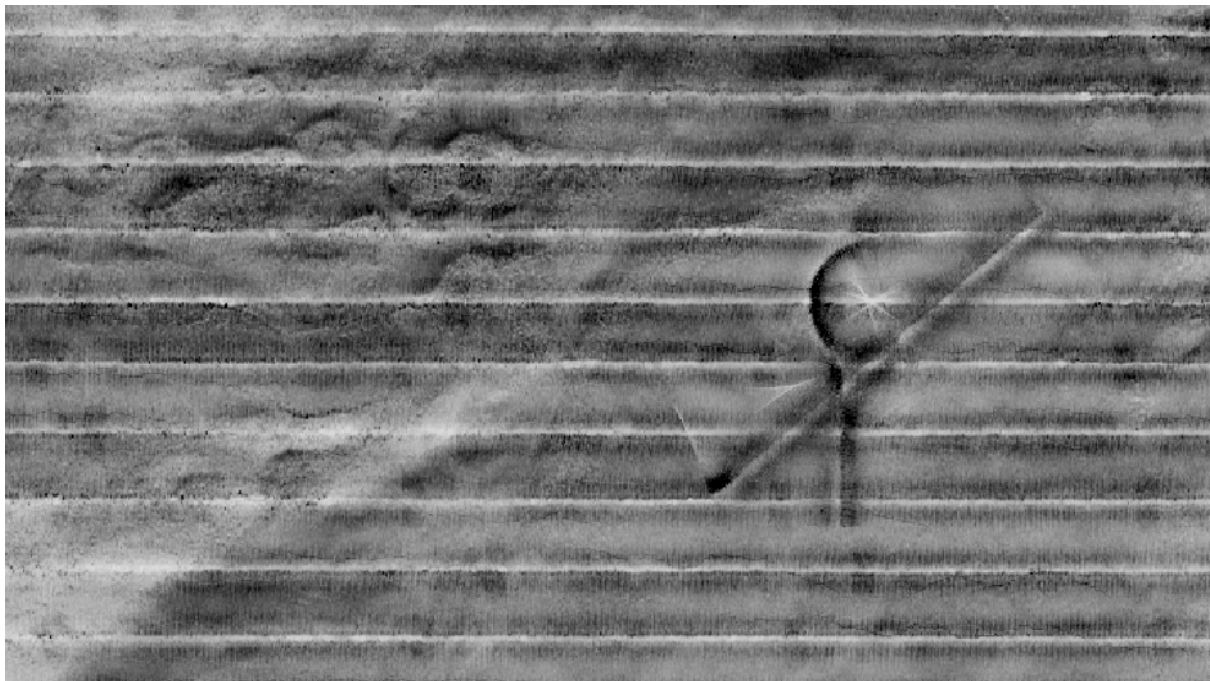


Figure 5 – bathymetry mosaic for Bay of Firth

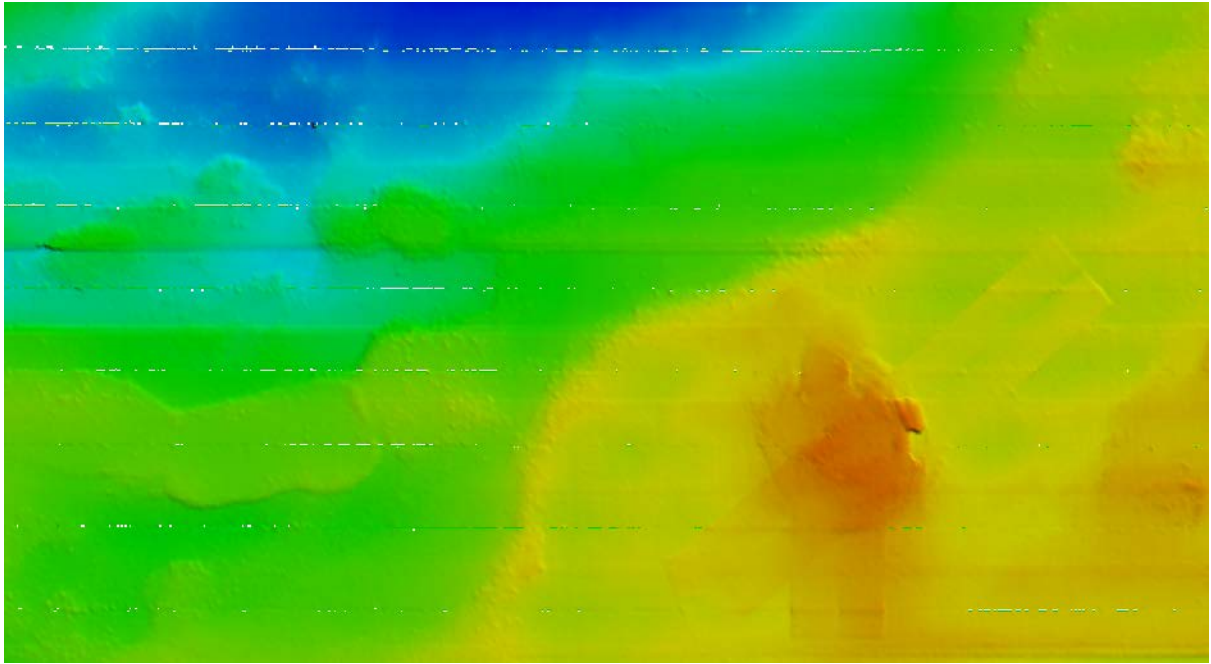


Figure 6 – Grasshopper still image example of seafloor on Bay of Firth

