NHPP 2D2 (Project 6205): Development and delivery of a pilot marine geotechnical training course for archaeologists.

Market Intelligence Gathering Report

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Teaching within the BOSCORF facility, NOCS. Marine Geoarchaeology course practical instructing students about how to interpret relict submerged palaeolandscapes using geotechnical vibrocores.

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Summary

In recent years there have been extensive geotechnical and environmental sampling survey programmes conducted by developers in support of numerous coastal and marine development projects, such as offshore wind farms, cable installations and port expansions. It is important that knowledge and understanding of the techniques and methodologies, that can reveal detail about the submerged heritage, are widely understood within the historic environment sector. It is therefore essential that national and local curators, and those working in the wider archaeological sector, are provided with an opportunity to develop knowledge, skills and practical experience in marine geoarchaeological analysis methodologies; this knowledge will enable staff to provide informed comment and advice based on a detailed understanding of the nature and archaeological potential of these offshore sites.

English Heritage commissioned COARS, University of Southampton, to undertake project 6205, "*Development and delivery of a pilot marine geotechnical training course for archaeologists*", under the National Heritage Protection Plan (NHPP) stream 2D2. The anticipated project outcome will be the delivery of a greater understanding of the skills shortages in this area, through a research component, and then use this information, in tandem with the decades of experience of the project team, to provide a pilot training course in marine geoarchaeological analysis (with a supporting toolkit of learning materials) for heritage practitioners in curatorial, investigation and research roles. The University of Southampton has been teaching Marine Geoarchaeology to Masters Maritime Archaeology students for fifteen years, throughout this time through combining the staff and resources of the Ocean and Earth Science and Archaeology Departments and world-class facilities available at the National Oceanography Centre, Southampton (NOCS).

This report details the methodology and results of the research component into skills shortages that exist within the area of marine geotechnical training for archaeologists. The research exercise was undertaking using an online survey which attracted 224 separate views and a total of 67 respondents who completed the survey.

1. Background

With the rapid expansion of coastal and offshore infrastructure projects, there have been extensive geotechnical and environmental sampling survey programmes conducted by developers, such as offshore wind farms, cable installations and port expansions. The large volume of material generated has a wide range of applications for interpreting the archaeological record and, as such, the way the material is handled and investigated is of great importance for understanding past landscapes and activities that took place within them. To ensure that this finite record is dealt with accordingly, it is essential that knowledge, skills and practical experience is developed within the wider archaeological community, as well as with those who handle and collect the material in the first place for survey companies. Such knowledge enables staff to identify, at an early stage, materials obtained that may have archaeological potential. Very few universities provide specific marine geoarchaeological training within their degree programmes (e.g. University of Southampton), so the number of practitioners entering commercial and / or local government associations with sufficient knowledge in marine geoarchaeology is currently insufficient to meet the growing need.

In England, English Heritage (EH) has provided advice for marine development projects since 2002, witnessing a large expansion of seabed development projects which require geotechnical material and environmental samples to support completion of Environmental Impact Assessment (EIA) exercises. To educate individuals and companies, engaging with the marine environment, EH have produced a number of Guidance Documents (e.g. BMAPA and EH 2003; Dunkley 2008; EH 2006; Firth 2013; Trow and Murphy 2003). However, where the guidance relates to palaeolandscapes, much of the focus has been directed towards data acquisition, processing and interpretation utilising geophysical techniques for seabed investigations, with the recently published *EH Guidance Notes on Marine Geophysics* (Plets, Dix and Bates, 2013) providing a thorough overview of these techniques. Other relevant guidance documents, often focused upon terrestrial sequences, have considered specific material types (e.g. Brunning and Watson 2012; Karsten *et al*. 2012), dating methodologies (e.g. Duller *et al*. 2008; EH 2004), or the broad fields of Geoarchaeology (Ayala *et al.* 2007) and Environmental Archaeology (Campbell *et al*. 2011). Recently, Dix and Sturt (2013) published a chapter on *Marine Geoarchaeology and Investigative Methodologies* within the *Maritime Archaeological Research Agenda for England*, providing a review of techniques available for offshore geoarchaeological investigations at a range of spatial scales, and identifying key research areas for the future. However specific Marine Geoarchaeology guidance on the acquisition, handling and investigation of geotechnical material (e.g. boreholes and vibrocores) and environmental samples (e.g. seabed grab samples and material from benthic trawls) is limited. Probably the most prominent guidance document covering this topic (and most cited in recent years), in relation to marine geotechnical investigations, is that by Gribble and Leather (2011), written for the renewable energy sector. Although this provides a good overview of the topic and sets out a framework for archaeological investigations, it provides very little detailed guidance for practitioners in a number of key areas, such as palaeoenvironmental sample assessments and analysis (covered in paragraphs 13.10 to 13.12), which has resulted in considerable disparity in the implemented investigation methodologies and data generated from such archaeological programmes.

Looking forward to future coastal and marine development projects, the knowledge gap has been acknowledged by EH. They have responded by identifying that there is a need for an audit of skills and

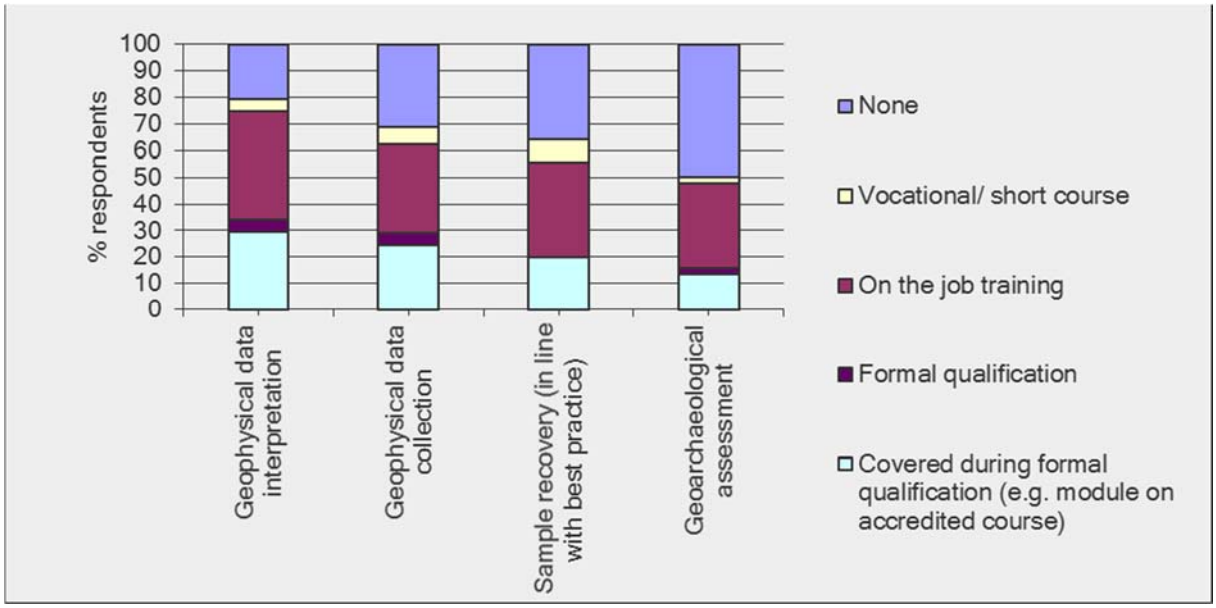
competency strengths and weaknesses, to fully identify where knowledge gaps exist, amongst national and local curatorial staff, the wider archaeological sector and geotechnical survey contractors. In anticipation of the perceived skill shortages, professional training has been identified as a requirement to ensure that technical understanding is embedded during the different stages of the production of a geoarchaeological technical report.

2. Previous Market Intelligence

It is acknowledged by EH, through identification of strategic training requirements, that a skill shortage exists in specialist services and post-excavation analysis (Aitchinson and Rocks-Macqueen 2013). An area identified as requiring further investigation, to supplement existing Labour Market Intelligence (LMI), are any skill shortages in the understanding, interpretation and use of geotechnical material obtained within the coastal and marine environment.

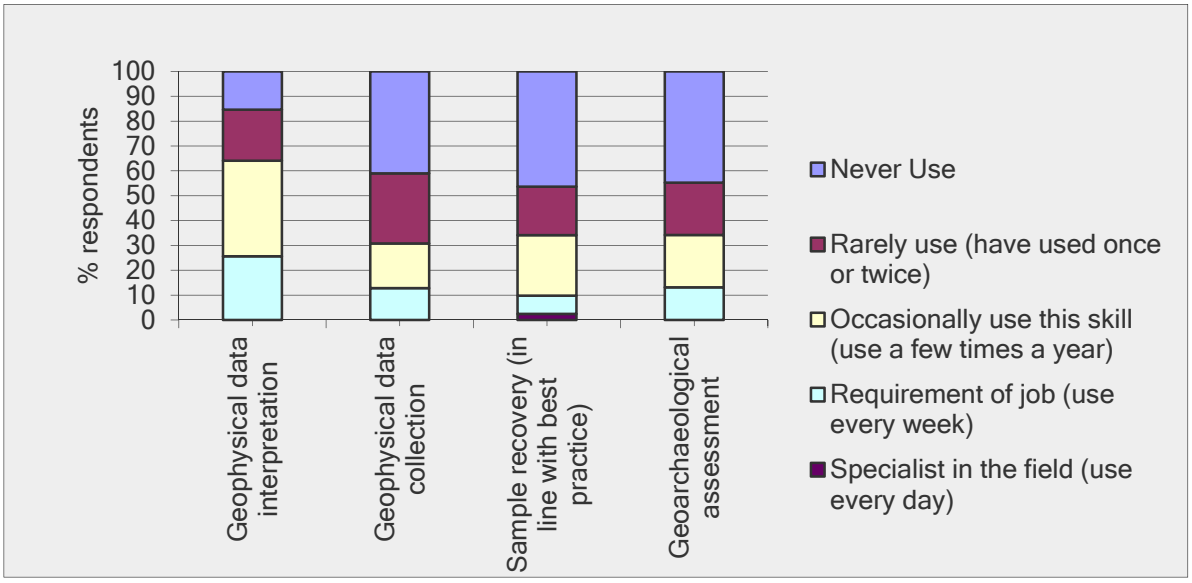
A recent survey (2014) undertaken by the *Institute for Archaeologists' Maritime Affairs Group* also questioned its members over their skills and training needs (total of 62 respondents to the survey). In response to the specific question over the level of training respondents had received in a range of topics relevant to the marine environment, 50% of respondents (from a total response count of 44-45 to each answer) had received some level of training in geoarchaeological assessment, 65% in sample recovery (including geotechnical samples), 70% in geophysical data collection and 80% in geophysical data interpretation (Figure 1).

Figure 1: Level of training received in marine-geoarchaeology related skills (data source: IFA Maritime Affairs Group)



This survey also sought to identify how often these skills were utilised (total response count was 38-41 to each answer). Of the four skills, the interpretation of geophysical data was most frequently used, with 25% using this skill every week and a total of 64% using it several times a year (Figure 2). This compared to c. 30-34% who used geophysical data collection, sample recovery (which had the lowest frequent usage) and geoarchaeological assessment several times a year.

Figure 2: Skill use, within practitioners (excluding students), in relation to marine geoarchaeology (data source: IFA Maritime Affairs Group)



Finally, in response to the question of training needs, from a total of 40 respondents, 30% (12 respondents) desired training in geophysical data interpretation, 23% (9 respondents) in geophysical data collection, 30% (12 respondents) in sample recovery and 18% (7 respondents) in geoarchaeological assessment. In a recent survey of the Scottish heritage sector (Atkinson and Bicket, 2013) over 70% of respondents stated they had not received any training in relation to the marine historic environment.

3. Project Scope

A key role of EH, in response to the National Heritage Protection Plan (NHPP) priorities, is to build external capacity in the workforce engaged in understanding, protecting and managing the historic environment. Training activity is one of the key contributions EH makes to building capacity in the historic environment sector.

In September 2013 EH produced *Historic Environment Workforce: Training Delivery Strategic Approach* (EH 2013). This document set out the approach EH was going to take for training delivery and focus in terms of:

1. Meeting gaps in the knowledge and skills related to specific NHPP topics;
2. Meeting skills gaps identified through recognised labour market intelligence; and
3. Meeting the needs of particular audiences.

Project 6205 relates to the development and delivery of a pilot marine geotechnical training course for archaeologists. The project will be delivered in four phases:

1. Research - into the skills shortages to further assess and define the demand for the training and the target audience (this report)
2. Design - of the pilot training course and an appropriate toolkit of supplementary training materials which meets the needs of the audience and delivers the content they need to cover.

3. Delivery of pilot course
4. Evaluation - production of a report evaluating this approach and recommending any future actions.

Specific aims and objectives have been identified for the current project.

2.1 Project Aims:

- To develop the knowledge, skills and appreciation of how geotechnical material obtained within the coastal and marine environment is used for geoarchaeological interpretation by improving our understanding of skills shortages and delivering a pilot marine geotechnical training course and toolkit of learning materials; and
- The target audience will comprise of heritage practitioners in curatorial, investigation and research roles, staff in archaeological units, commercial heritage consultants and professional marine survey contractors.

2.2 Objectives

The project will:

1. Provide an understanding of the skill shortages that exist in the sector; demonstrating clearly who the audience is, what level of demand there is for training and what specific content the training should cover (this report);
2. Deliver a pilot training course to meet the skills shortages which will include the development of a learning toolkit to supplement the training;
3. Provide a learning environment that includes access to written learning materials, expert speakers, practical laboratory demonstrations, discussion opportunities and, where it meets the learning needs of the delegates, access to see the equipment and platforms used in coastal and marine geotechnical survey;
4. Provide an introduction, explanation and demonstration of marine sedimentary conditions, Quaternary geomorphological principles and the techniques and methodologies that support marine geoarchaeological analysis and interpretation;
5. Develop practical experience and understanding of processing geotechnical material to support historic environment analysis and modelling techniques;
6. Develop an understanding of the techniques employed to describe and illustrate the results of the analysis, such as sedimentary sequence deposit models to reconstruct prehistoric submerged and buried landscape features that have the potential to contain archaeological evidence;
7. Explain how geoarchaeological reports should effectively identify risk and inform the selection of viable mitigation strategies; and
8. Provide an evaluation of the effectiveness of the pilot in bridging skills shortages and provide options for future delivery.

3. Identified audiences.

The following audience groups have been identified in the *Historic Environment Workforce: Training Delivery Strategic Approach* and are considered to be in scope for this programme. These audiences will be further refined in the research phase of the project.

- Curatorial roles (local authority Historic Environment Services) – those who look after, in a management context, the historic environment such as Archaeological Curators;
- Commercial marine survey contractors – those that work on behalf of developers to acquire geotechnical survey material to address engineering parameters, but will not be familiar with how the same material is used for geoarchaeological interpretation;
- Parties that undertake invasive and non-invasive investigation for assessment, recording and analysis on sites or assemblages produced from sites with archaeological interest – those who undertake fabric analysis for identification, analysis, survey and evaluation such as staff in archaeological units and commercial heritage consultants; and
- EH staff, primarily within National Planning and Conservation Department, whose role involves advising on coastal and marine development projects.

4. Research Methodology

In order to inform the content of the training course, a research exercise has been undertaken to investigate the availability of knowledge and skills in the understanding, interpretation and use of geotechnical material obtained within the coastal and marine environment and produce an assessment of the level of demand for training. The generation of the survey followed a series of iterative stages:

1. Development of a draft survey (UoS) for consultation with representatives of the immediate English Heritage team, consisting of Christopher Pater (Head of Marine Planning and Project lead), Rachel Prosser (Capacity Building Team, English Heritage) and Jonathan Last (project Quality Assurance officer).
2. Revised survey circulated within English Heritage for comment, including representatives of the Science Advisors, Environmental Studies, Geophysics and Scientific Dating teams.
3. Compilation of all comments into a final survey and final consultation with Christopher Pater.
4. Construction of an online survey, using the University of Southampton iSurvey (https://www.isurvey.soton.ac.uk/) system.
5. Launch of survey and contacting of potential recipients.

The survey was disseminated through email and online blog sites, targeting the identified audiences stated in Section 3. The questions contained within the survey are given in Appendix A. Points of dissemination included (but not exclusively):

- Institute for Archaeologists (IFA; http://www.archaeologists.net/) , including the IFA Maritime Affairs Group (MAG; http://ifamag.wordpress.com/);
- Association of Local Government Archaeological Officers (ALGAO; http://www.algao.org.uk/);
- Specialist Research Groups, including Quaternary Research Association (QRA; http://qra.org.uk/) and Association of Environmental Archaeology (AEA; http://envarch.net/);
- English Heritage staff, including the English Heritage Science Network
- National Heritage Science Forum (http://www.heritagescienceforum.org.uk/)
- Advertised through both COARS (http://www.southampton.ac.uk/coars/) and University of Southampton news feeds and blog sites.
- Selected survey contractors, consultancies and marine infrastructure companies.

The survey was made publically available on Tuesday 20th May 2014 and ran until Sunday 8th June 2014. All data was collected within the iSurvey portal via Secure Sockets Layer (SSL) encryption, and stored on a secure central database server that was backed up daily with all data archived for 90 days. At the end of the survey the full dataset was downloaded and prepared for analysis. A number of respondents from outside the UK also participated in the survey, including the United States of America, Australia and Japan. Comments made within the survey have been abridged in some instances, where included within this report, to protect the respondent's identity. The research exercise was undertaken using an online survey which attracted 224 separate views and a total of 67 respondents who completed the survey. A summary of the results is provided below. A full breakdown of the results from Sections 4 to 8 (Geoarchaeological Components), split by the three main job categories, is given in Appendices B to F.

5. Results

5.1 Background Information

Respondents were asked to select one of three overarching job categories, consisting of:

- Curatorial Roles (Historic Environment Services): Those who look after, in a management context, the historic environment
- Investigation and Research: Those who undertake invasive and non-invasive investigation for assessment recording and analysis on sites or assemblages produced from sites with archaeological interest
- Non Heritage professional and practitioner: Those whose work bring them into regular contact with the historic environment and whose decision making may impact upon it

Within these three categories, a job role was selected (Table 1). The breakdown of respondents, by category and role, is given below. The highest proportion of respondents (72%) was generated from the Investigation and Research category. The lowest response rate (6%) was from the non-heritage professional category. This low response rate was to be expected as this category is likely to be the one that engages the least with heritage assets and therefore least likely to wish to participate in the online survey. The job roles with the greatest number of respondents were Archaeological Specialists and Researchers (25% each), followed by Archaeological Contractors (15%) and Archaeological Curators (12%).

Table 1: Job Role in Job Category

	Curatorial	Investigation and Research	Non Heritage Professional	Total
Archaeological Curator (County Archaeologist)	8			8
Historic Environment Records Officer	2			2
Archaeological Contractor		10		10
Archaeological Specialist		17		17
Researcher (University or Freelance)		17		17
Surveyor / Engineer		2		2
Project Manager			1	1
Other	4	1	3	8
Role not provided	1	1		2
Total	15	48	4	67

In relation to job status, the majority of respondents were full-time employed (69%), with 10% part-time employed, 10% students and 7% self-employed (Table 2).

Table 2: Employment Status

	Curatorial	Investigation and Research	Non Heritage Professional	Total
Self employed		5		5
Part time employed	3	4		7
Full time employed	12	30	4	46
Student		7		7
Retired		1		1
Not given		1		1

Of the 67 respondents, 32 (48%) stated that they were involved with environmental assessment programmes for marine development projects, with 42 (63%) stating that their organisation had a primary focus was upon archaeology / heritage (Table 3).

Table 3: Environmental Assessment and Organisation Focus

	Curatorial	Investigation and Research	Non Heritage Professional	Total
Are you involved with environmental assessment programmes for marine development projects?	12	18	2	32
Is your organisation primarily focused upon archaeology / heritage?	6	36	0	42

There was a wide variation in the number of archaeological / heritage staff employed within each respondent's organisation. The categories with the greatest response (19%) were those employing 2-5 staff or over 101 staff (Figure 3 and Table 4). The latter is likely to be a skewed representation of the industry as a whole due to a number of respondents from the same large organisation. Four respondents (6%) employed no archaeological / heritage staff within their organisation with 12% (8 respondents) stating they only had one such member within their organisation.

Figure 3: Archaeological / Heritage Staff within Organisation

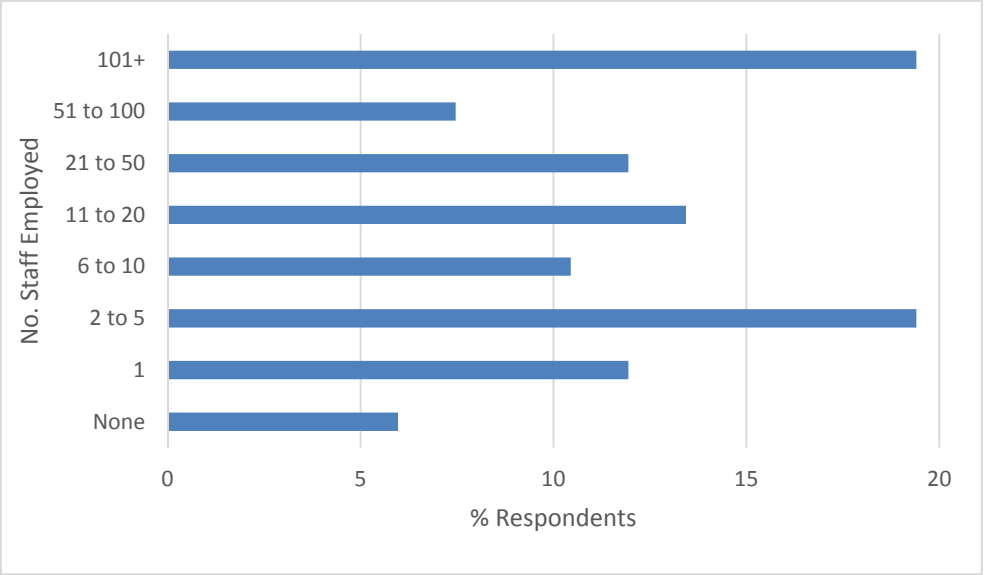


Table 4: Archaeological / Heritage Staff within Organisation, by Job Category

	Curatorial	Investigation and Research	Non Heritage Professional	Total
None		2	2	4
1	3	5		8
2 to 5	6	6	1	13
6 to 10	1	5	1	7
11 to 20	1	8		9
21 to 50		8		8
51 to 100	1	4		5
101+	3	10		13

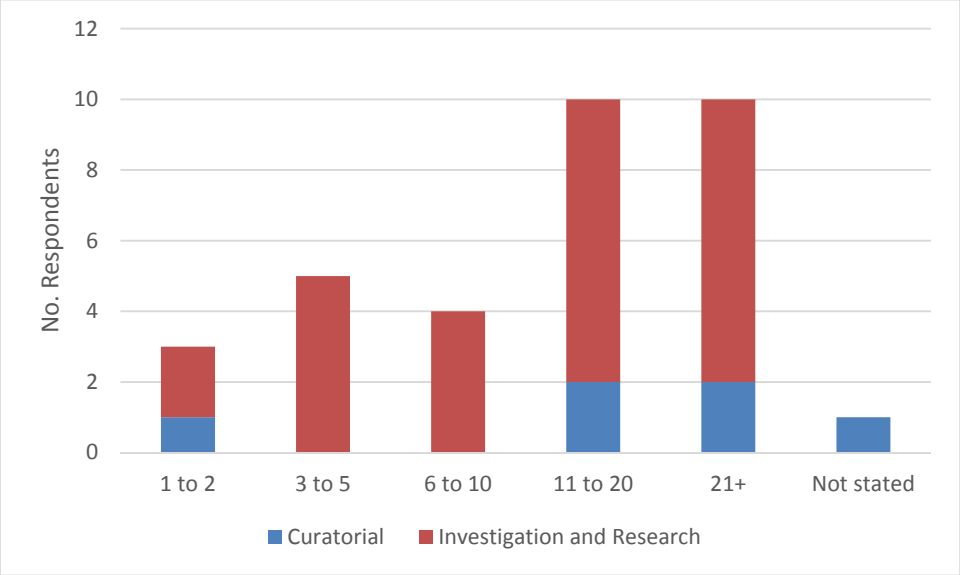
When questioned over how many fellow staff, within the respondent's organisation, that they considered had specialist skills in environmental archaeology / geoarchaeology, 21% stated that they had no specialist staff (33% of Curatorial, 15% of Investigation and Research, and 50% of the Non-heritage category) (Table 5). 18% of respondents stated that they had greater than 10 specialists within their organisation (13% of Curatorial and 21% of Investigation and Research categories). 49% of respondents considered themselves a geoarchaeologist / environmental archaeologist, including 40% within the Curatorial category, 56% within the Investigation and Research category, but none within the Non-heritage category.

Table 5: Co-workers with skills in environmental archaeology / geoarchaeology

	Curatorial	Investigation and Research	Non Heritage Professional	Total
None	5	7	2	14
1 to 2	5	13		18
3 to 5	2	8	1	11
6 to 10	1	10	1	12
11+	2	10		12
Do you regard yourself as a geoarchaeologist / environmental archaeologist?	6	27	0	33

Of those who self-identified as a geoarchaeologist / environmental archaeologist, 73% (24 respondents; 10 of which were university researchers) held a doctorate degree, 18% (6 respondents) held a postgraduate degree, 6% (2 respondents within Investigation and Research category) had an undergraduate degree, while one didn't state their highest qualification. With regard to the number of years of experience, 30% had 11 to 20 years' experience and 30% had over 21 years' experience. 9% had 1 to 2 years' experience, 15% had 3 to 5 years' experience, and 12% had 11 to 20 years' experience (Figure 4).

Figure 4: Respondents' Years of Experience in Geoarchaeology / Environmental Archaeology



5.2 Provision of Marine Geoarchaeological Specialisms

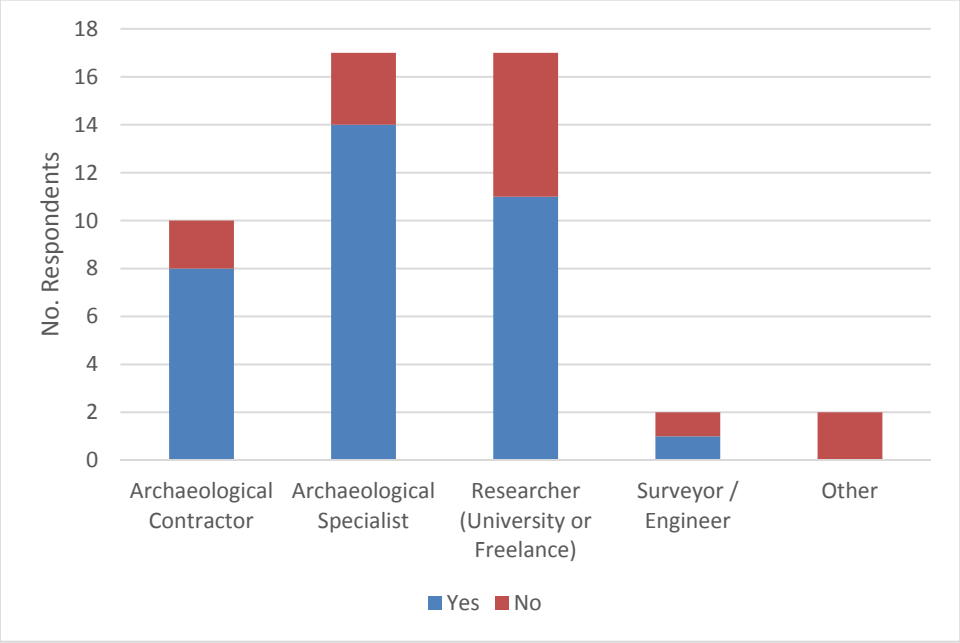
All respondents stated that they understood that material derived from geotechnical methods / techniques (e.g. boreholes, grab samples) are important for archaeological purposes, while 96% (64 respondents) stated that they knew that marine geophysics is an important technique in marine geoarchaeology. 77% of respondents were aware of one or more of the following guidance documents:

- Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector (2011: Gribble and Leather; published by COWRIE Ltd).

- Marine Geophysics Data Acquisition Processing and Interpretation: guidance notes (2013: Plets, Dix and Bates. Published by English Heritage).
- Geoarchaeology: Using earth sciences to understand the archaeological record (2007: Ayala, Canti, Heathcote, Sidell and Usai; published by English Heritage).
- Environmental Archaeology. A Guide to the Theory and Practice of Methods from Sampling and Recovery to Post-excavation (2011: Campbell, Moffett and Straker. Published by English Heritage)

This included 93% (14 respondents) of the Curatorial category, 73% (35 respondents) of the Investigation and Research category, and 75% (3 respondents) of the Non-heritage category. Within the Investigation and Research category, the greatest proportion of individuals unaware of the current guidance documentations resided within the researcher job role (35% of job role respondents), with 19% of archaeological contractors and specialists questioned also unaware of these documents (Figure 5).

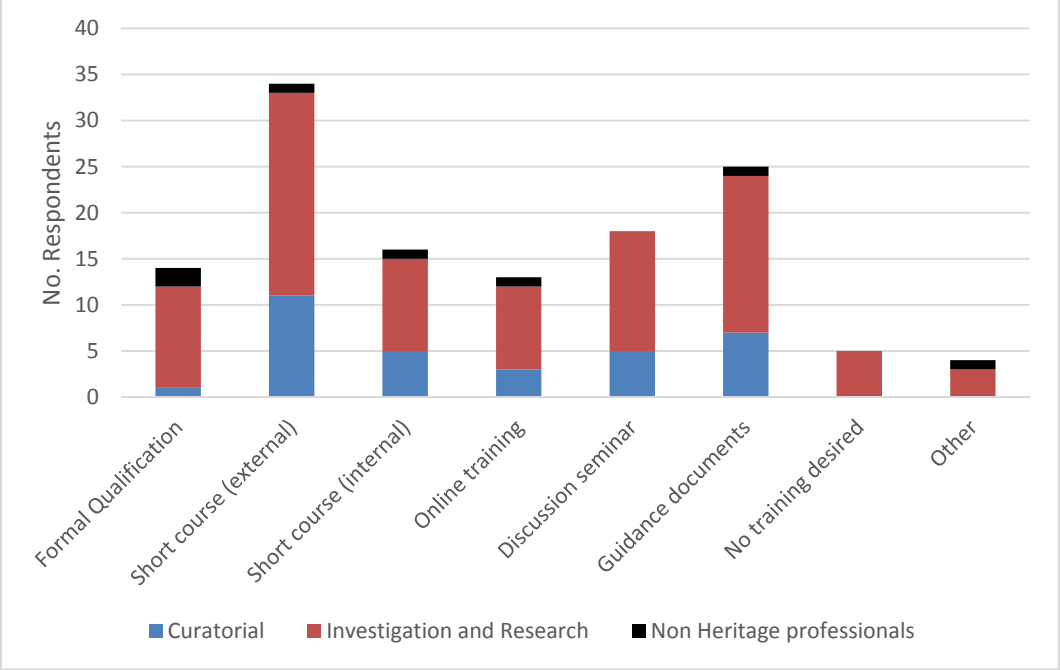
Figure 5: Number of Respondents, within Investigation and Research Job Category, Aware of Available Guidance Documents



5.3 Training requirements

75% of respondents (50 respondents) said that they had received training in geoarchaeology, environmental archaeology or geochronology, though 93% of respondents expressed interest in some level of training within the field of marine geoarchaeology. Six training options were posed to each respondent. The two options gaining the most support were a short course (external to their organisation), at 51%, and a guidance document, at 37% (Figure 6).

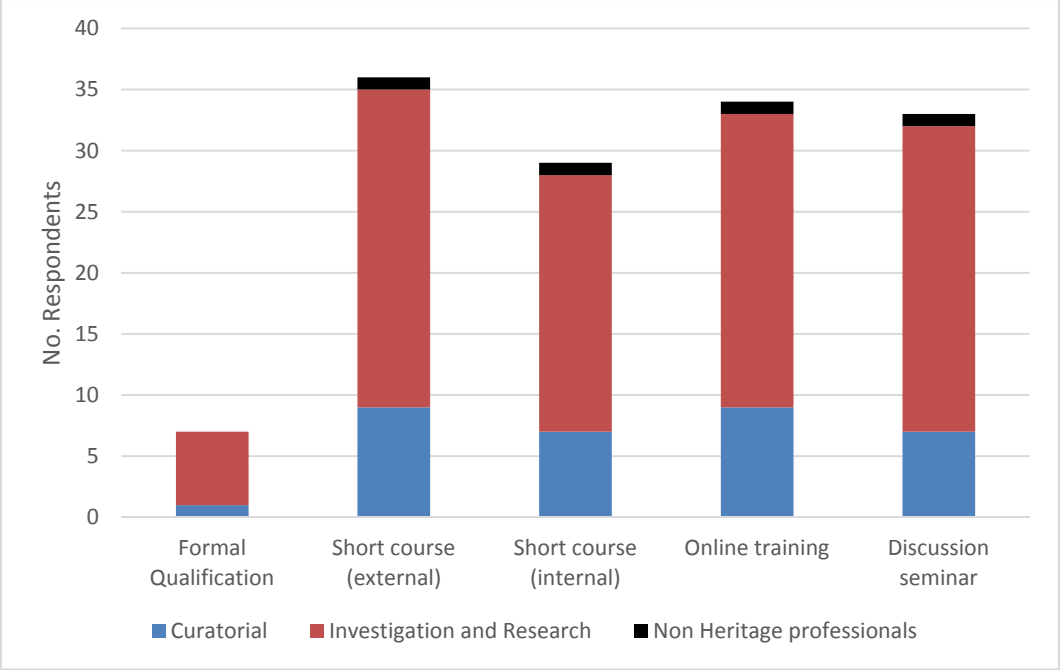
Figure 6: Potential Training Options with Positive Responses



When questioned over whether the respondent felt that their organisation (or themselves if self-employed) might fund training attendance, 49-54% of all respondents indicated that short external courses, online training and discussion seminars would likely be the most favoured options. A short internal course obtained 43% support, but most respondents felt that their organisation would offer no support for a formal qualification related to marine geoarchaeology (Figure 7).

The respondents were then told that "as part of the NHPP 6205 project the University of Southampton, in partnership with English Heritage, will be running a three day training course in January 2015, focusing on geoarchaeological techniques and methodologies using seabed and sub-seabed sediment samples obtained during geotechnical surveys". When asked whether they would be interested in attending this training event 60% of respondents stated that they would be interested in attending such a course, with 60% within the Curatorial category (9 respondents) expressing interest, 58% within the Investigation and Research category (28 respondents) and 75% (3 respondents) within the Non-heritage category.

Figure 7: Respondents Who Felt Their Organisation Would Fund a Particular Training Option

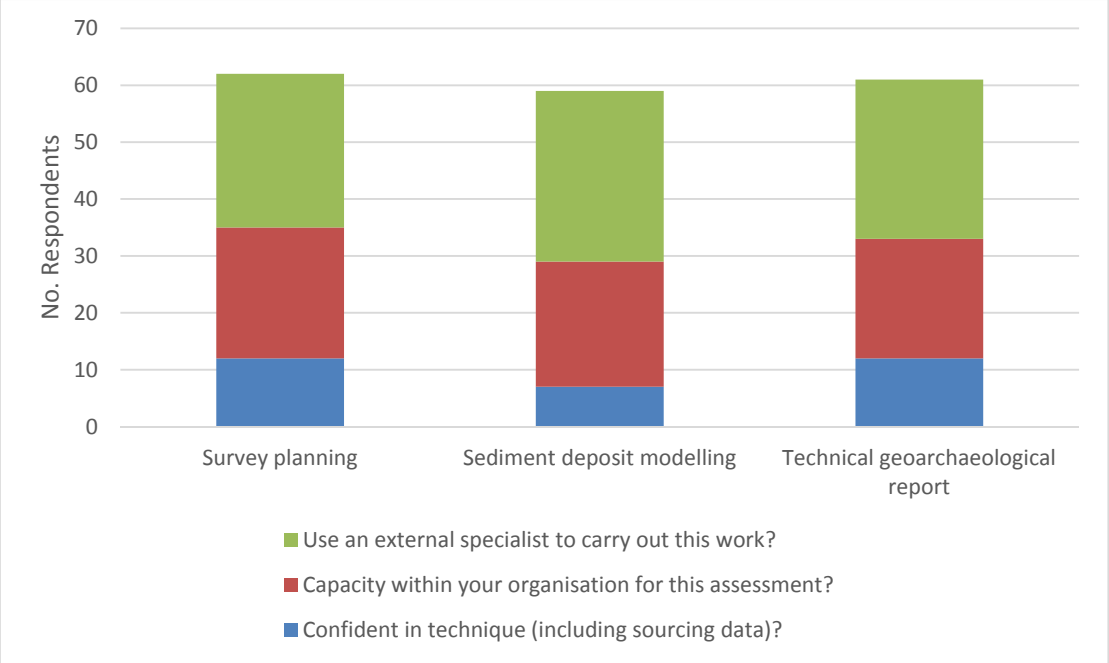


5.4 Geoarchaeological Components: Desk Based Studies

From this point forward, the survey turned towards specific investigation stages, and techniques, that can be used within marine geoarchaeology. The first section concerned a range of different desk-based studies. Each respondent was asked which [of three] approaches they were confident in, if there was a capability within their organisation to undertake the work, and whether they used external parties to conduct the work on their behalf. Only 18% of respondents said that they were confident in planning / scoping a geotechnical survey, including the selection of suitable sampling techniques (Figure 8). 34% said that they had such a capacity within their organisation, while 40% said that they used an external party to carry out this work.

10% of respondents stated that they were confident in the technique of sediment deposit modelling, including sourcing data suitable for inclusion in such a model. 34% said that they had such a capacity within their organisation, while 45% stated that they had used an external specialist for this work. 18% of respondents stated that they were confident in the production of a technical geoarchaeological report. 31% said that they had such a capacity within their organisation, while 42% stated that they had used an external specialist for this work. Across all three questions within this section, the Curatorial category appeared to have the least knowledge and capacity for these type of studies and greatest percentage (66% within this category) of commissioning of external specialists to undertake the work on their behalf. The number of respondents within the Non-heritage category was too low to provide any meaningful percentages but did suggest similar knowledge and capacity levels to the Curatorial category.

Figure 8: Number of Positive Responses to Geoarchaeological Components: Sediment Analysis Results



When questioned over the use of Geographic Information Systems (GIS), 72% of respondents said that they used such software (Table 6). The percentage was greatest within the Curatorial category (87% of category respondents), with 69% of the Investigation and Research category also indicating use of such software. A wide range of software packages are used for the management of geographic information, with the ESRI ArcGIS software most frequently cited as used. A number of respondents did state that they use multiple software platforms.

Table 6: GIS Training and Software Usage Listed by Respondents

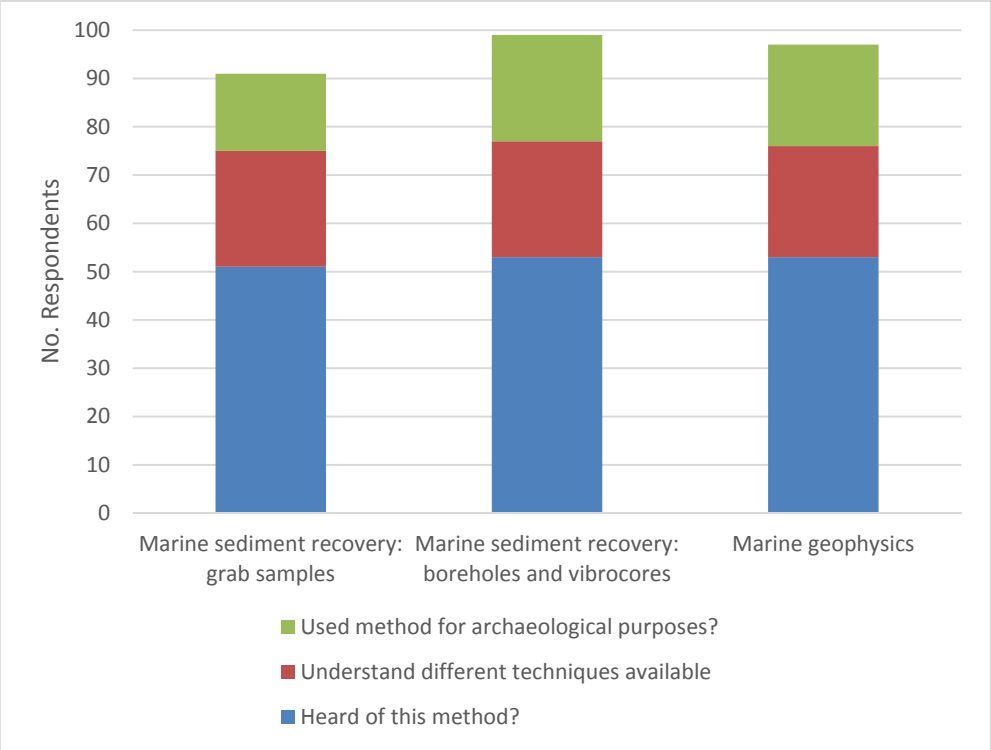
	Curatorial	Investigation and Research	Non Heritage professional	Total
Do you use GIS software?	13	33	2	48
Which software do you use?				
MapInfo	2			2
ArcGIS	6	20	2	28
qGIS		3		3
AutoCAD		2		2
Grass		1		1
gvSIG		1		1
Site Recorder		1		1
Trimble		1		1

5.5 Geoarchaeological Components: Prospecting and Sampling

Section 5 of the survey turned to techniques that were available for obtaining material / data for marine geoarchaeological purposes. This consisted of three principal techniques: grab samples, boreholes and vibrocores, and marine geophysics. A similar response, both in total numbers and within the specific categories, was found for all three methods. 76-79% of respondents claimed to

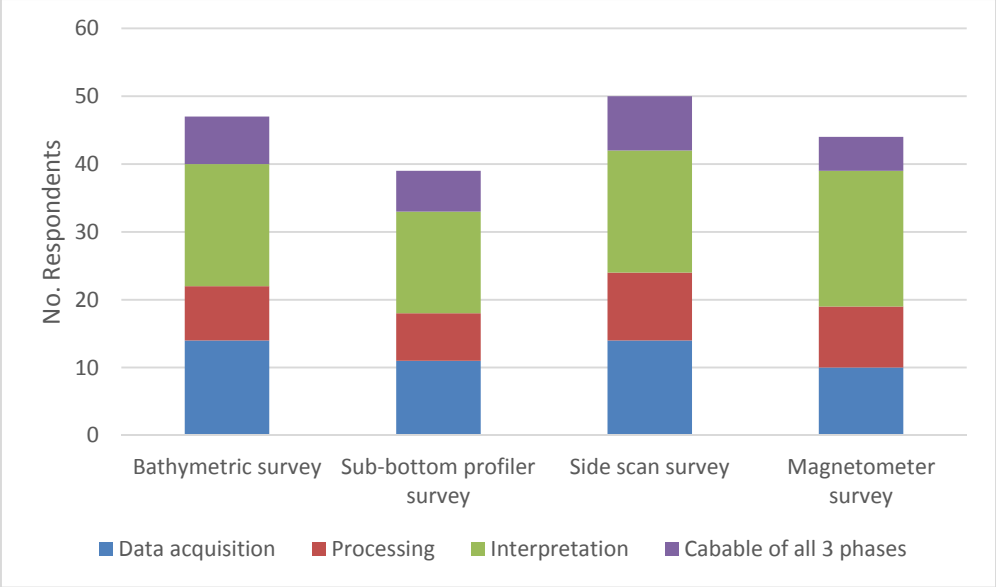
have heard of each technique (Figure 9). However the number of respondents who claimed to understand the different techniques available was 34-36% of total respondents. 43-47% respondents who had heard of the methods also claimed to have some understanding of different techniques available. Vibrocores and Boreholes were found to have been the most frequently used method for archaeological purposes (33%), with marine geophysics (31%) having a similar level of uptake, while grab sampling (24%) had the lowest usage for archaeological purposes.

Figure 9: Number of Positive Responses to Geoarchaeological Components: Prospecting and Sampling



This question was followed up with a probe into the level of expertise that respondents had in working with a series of different marine geophysical techniques (Figure 10). Across all four principal techniques (bathymetric, side scan, sub-bottom profiler and magnetometer surveys) few respondents claimed to understand the full process from data acquisition to interpretation (7-10% respondents). This was most prominent for magnetometer surveys where only 25% (5 out of 20 respondents) who used this data for interpretation also understood how the data was acquisitioned and processed. Across all four categories the highest number of respondents, claiming expertise, was in the interpretation stage, with the fewest number of respondents in all four categories understanding how the data was processed (from raw acquisition) prior to archaeological interpretation.

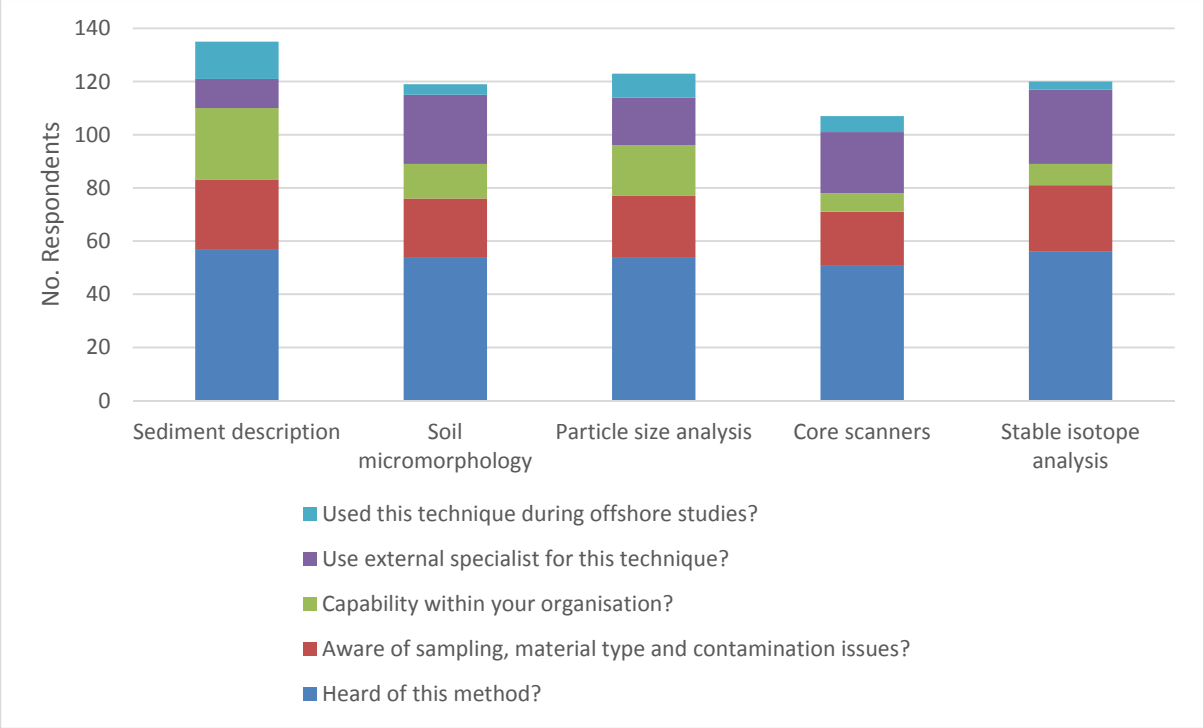
Figure 10: Marine Geophysics Expertise



5.6 Geoarchaeological Components: Sediment Analysis

The survey then questioned each respondent about a series of different sediment analysis techniques that can be used for describing and analysing sediments for marine geoarchaeological purposes. Many of the respondents said that they had heard of each method (76-85%), with sediment description and stable isotope analysis the best known techniques (Figure 11). Awareness of sampling, material type and contamination issues for each of these techniques was significantly lower, with 30-39% claiming they understood these issues. Capacity to undertake these techniques was low in both the Curatorial (7-20% respondents) and Non-heritage (0%) categories, while within the Investigation and Research category organisation capacity ranged from 52% (sediment description) to 12% (core scanners; such as X-rays and continuous XRF scanners) of respondents. External specialists were most frequently used for stable isotope analysis (42%), soil micromorphology (39%) and core scanning technology (34%), with the lowest use of external specialists for sediment descriptions (16%). In relation to use within offshore studies, sediment description was the most popular technique (21%), followed by particle size analysis (13%). The least used technique was stable isotope analysis (4% of respondents; all within the Investigation and Research category).

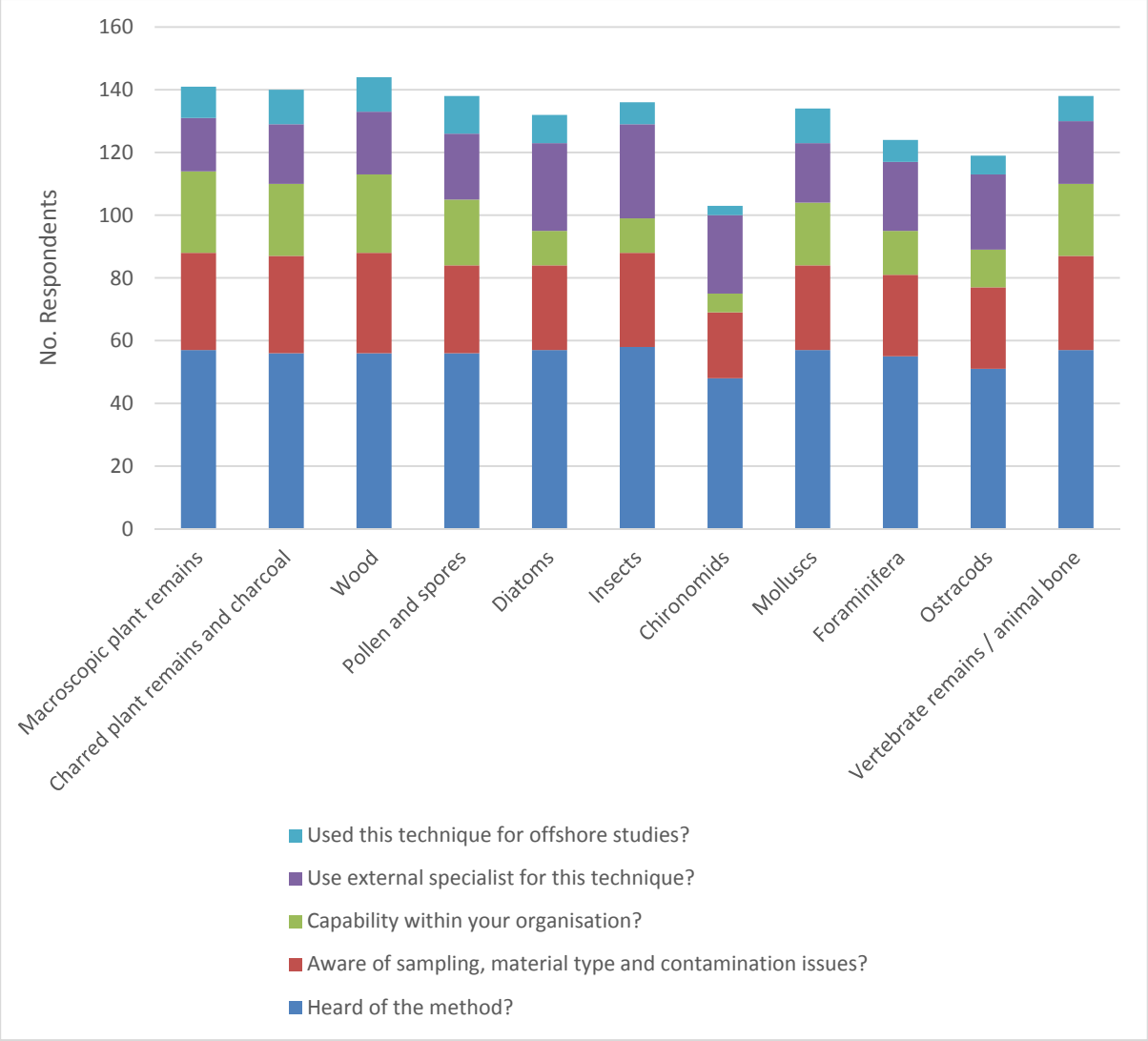
Figure 11: Number of Positive Responses to Geoarchaeological Components: Sediment Analysis



5.7 Geoarchaeological Components: Environmental Archaeology

The survey then questioned each respondent about a range of the most commonly applied environmental archaeology techniques suitable for marine geoarchaeological purposes. Additional techniques that had been used in the marine environment, omitted from the list (e.g. phytoliths), were also identified by a number of respondents, normally in relation to their own specialism, in the comments section. There was a strong consistency in the number of respondents (84-85%) who had heard of many of the techniques, with chironomids (72%) and ostracods (76%) the least known techniques (Figure 12). Within the Curatorial category, the awareness of each technique ranged between 60% (for chironomids) and 87% (for diatoms, insects, molluscs and vertebrate remains) of respondents. Awareness of sampling, material type and contamination issues was claimed to be highest for wood remains (48%) with chironomids (31%) the lowest, followed closely by foraminifera and ostracods (39%) and molluscs and diatoms (40%). Capacity within the respondents' organisation was lowest for chironomids (9%), followed by insects (16%) and ostracods (18%), but highest for macroscopic plant remains (39%) and wood (37%). The use of external specialist was highest for insects (45%), diatoms (42%), chironomids (37%) and ostracods (36%), but lowest for macroscopic plant remains (25%), charred plant remains and charcoal (28%), wood (30%), molluscs (28%) and vertebrate remains (28%). Within the Curatorial category, only two respondents were aware of an internal capacity for macroscopic plant remains with only one respondent for all other techniques. On the question of use of these techniques within offshore studies, chironomids again had the lowest uptake (4%), followed by ostracods (9%), foraminifera and insects (10%), while molluscs, wood, charred plant remains (all 16%) and pollen and spores (18%) the most frequently used. Within the Curatorial category, two respondents indicated that they had used a number of the environmental archaeology techniques in offshore studies, but these techniques did not include diatoms, ostracods or foraminifera.

Figure 12: Number of Positive Responses to Geoarchaeological Components: Environmental Archaeology

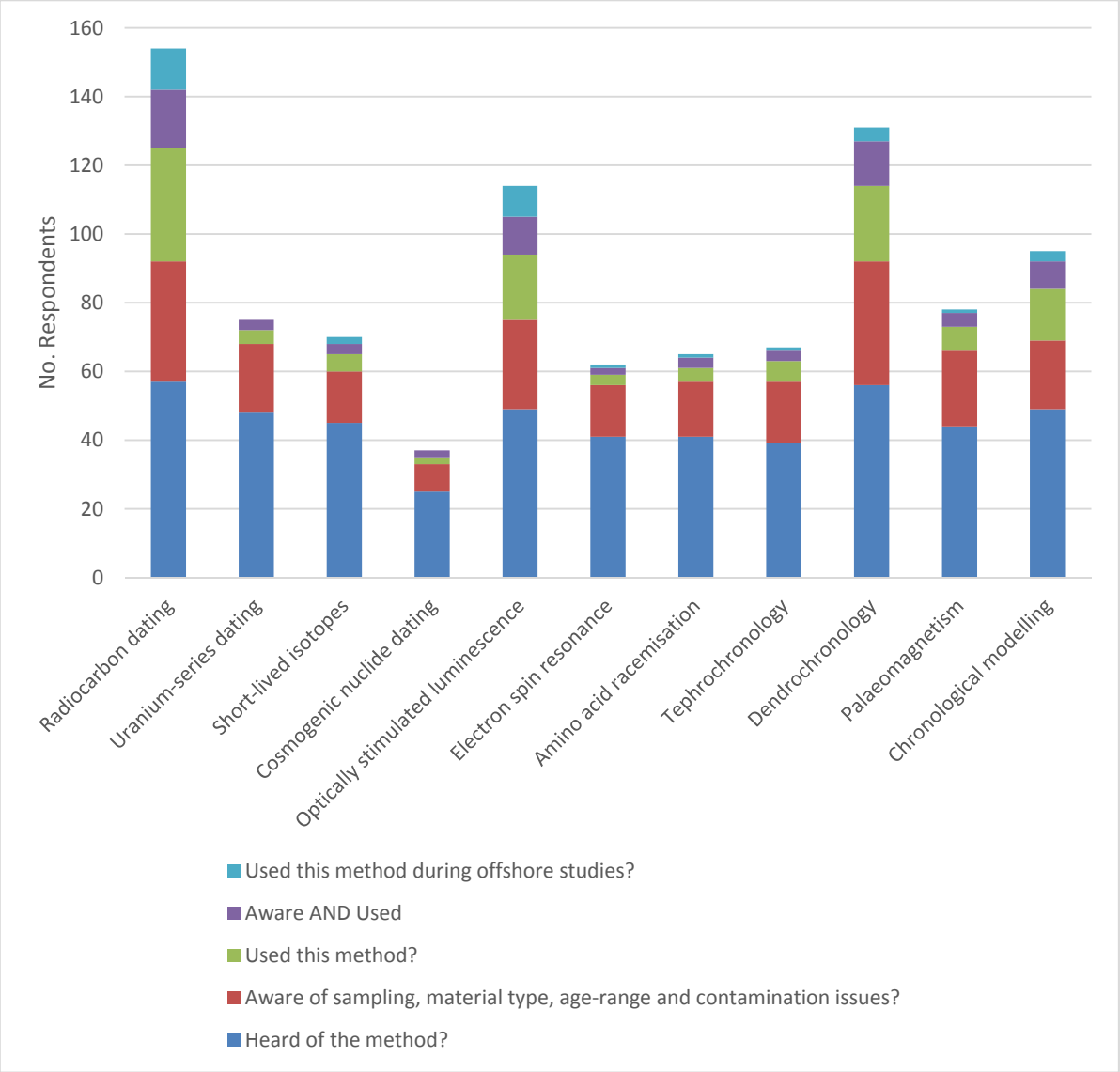


5.8 Geoarchaeological Components: Chronology

The final section of the survey dealt with a range of techniques available for determining the age of sediments for geoarchaeological purposes. Radiocarbon dating (85%) and dendrochronology (84%) were the best known techniques, followed by Optically Stimulated Luminescence (OSL) (73%) (Figure 13). A large number of respondents also said that they had heard of chronological modelling techniques (73%), such as age-depth modelling and Bayesian statistics. The least known technique listed was Cosmogenic nuclide dating (CND; 37%), with techniques such as Electron Spin Resonance (ESR) and Amino Acid Racemisation (AAR) heard of by 62% of respondents, and tephrochronology by 58%. Respondents claimed to be most aware of sampling, material type, age-range and contamination issues for the dating techniques of radiocarbon dating (52%) and dendrochronology (54%), followed by OSL (39%). A similar pattern was found in the use of techniques, with radiocarbon dating (49%), dendrochronology (33%) and OSL (28%) most frequently used. CND, ESR, AAR and Uranium-series dating were the least used techniques (3-6%). 22% of respondents had used / commissioned chronological modelling. However, when the number of respondents who claim to understand each techniques issues / limitations is compared against the number that used the technique, a much lower percentage is generated. For radiocarbon dating, 51% who used the technique understood the

sampling, material type and contamination issues, with similar levels for OSL (58%) and dendrochronology (59%). For the less well known techniques, competency levels appeared higher (66-100%; albeit within a smaller sample pool) within those that had used the technique. For offshore studies, radiocarbon was the most used technique (18%), followed by OSL (13%) and dendrochronology (6%). Many of the other techniques either hadn't been applied in a marine context or only used by a single respondent. Chronological modelling had only been used by three respondents in the marine environment, even though 12 respondents said they had used radiocarbon dating in this environment.

Figure 13: Number of Positive Responses to Geoarchaeological Components: Chronology



5.9 Final comments

The following comments were provided by respondents which provide some useful addition insights:

"Formal training, university courses and internship opportunities in geoarchaeology are very thin on the ground, not just in the UK"

“Haven't personally 'used' the majority of techniques in a marine setting, but have routinely recommended and/or stipulated that they be used in my curatorial role”

"I would suggest that there is a very poor understanding of geo-archaeological and environmental issues within the archaeological community.”

“There are few, if any, curatorial archaeologists with training in any of these areas and all too often there is a reliance on specialists who may be pursuing their own interest rather than providing the holistic picture needed to significantly add to the current knowledge base. In other words the brief for this type of work is not correctly infirmed and curators have difficulty in determining the appropriate course of action. This is particularly the case for marine and underwater work. Having said that most curators do not deal with maritime issues … and get involved by default.”

“My interest in training would be in updates and discussion about recent practical examples and the continuing development of 'best practice'. I wouldn't want to spend time on 'the basics' of how geoarchaeological work is conducted, just on keeping up to date. Three days would be much more than I could afford to spend on a training course, but a one day update would be useful.”

"My perception is that there are individual experts in the constituent skills dotted round the UK. But as they are located at different organisations, and funding / support for skills development and research are normally tied into the parent institution, that it is difficult for individuals and organisations looking to develop their skills to source the support they need.”

"The use of this sort of data for archaeological purposes is quite specialised. However, there is often the feeling amongst company directors who want to push into new areas that marine archaeology is just terrestrial archaeology, though a bit wetter. When trying to devise training for specialist fields there needs to be care that those without sufficient training do not set themselves or their organisations up as consultants who are specialised in this field. I have seen examples where people who have done a 3-day [specialist] course then try to engage in regular [specialist] work on the back of this training.”

“Sometimes training events in scientific methods just repeat what is said in the EH Guidelines on the topic, as if the training even was to facilitate those too lazy to read the guidelines themselves. What is often not discussed is where these specialist services can be sought… often those who promote certain techniques do not clearly state their pitfalls."

6. Synthesis of Results

The survey managed to target a relatively large number of respondents, though representation of the Curatorial and, in particular, the Non-Heritage category was lower than desired, meaning respondent comments may not be truly representative of the category as a whole. The audit of the three principal job categories identified the greatest pool of archaeological / heritage staff (>10 individuals per company) lay unsurprisingly within the Investigation and Research category, while those within the Curatorial category were often working within small teams (<5 persons; 60% respondents) or isolation. Many of the Curatorial respondents did claim to have received some previous training in geoarchaeology / environmental archaeology (87%) compared to both Investigation and Research (71%) and Non-heritage (75%) categories. Awareness of any of the four stated existent guidance

documents was lower than expected (77% of respondents), and lowest within the Investigation and Research category (at 73%), indicating that one in four practitioners were working without any awareness of the relevant English Heritage archaeological guidance. Better dissemination / awareness of this documentation, including advertising of the fact that new documents have been released, should be considered.

The survey has identified that there is a desire for further training opportunities, across the different job categories, within the field of marine geoarchaeology. The favoured delivery portal for training was identified as a short external course, with guidance documents the second most popular format.

There is a good general awareness of the range of techniques available for geoarchaeological studies but the main knowledge gap exist within the application of these techniques. This includes assessment of the suitability of different techniques, areas of potential sample contamination and sampling techniques. However it is unclear whether external specialists are consulted, when commissioned to undertake the work, during the early sampling stages to help direct decisions over material type suitability. It is likely, however, that in many cases external specialists are simply provided with sub-sampled material which might have inherent contamination issues and be unsuitable to meet the project aims. The question over the respondents' perceived level of knowledge is also a somewhat speculative statement, with the potential that some practitioners, having undertaken a short course (as stated in the additional comments), perceiving themselves as specialists, albeit with very limited actual experience.

With regard to the three tasks listed under the desk-based studies category there was very little confidence in the techniques outlined within the Curatorial category, who rely heavily upon external specialists to undertake the work (and presumably write the job specifications in some instances). Confidence in the use of these techniques was also generally low within the other two categories and, although a capacity was claimed to exist within their respective organisations, there was still often a reliance on external specialists to perform these tasks. Use of GIS software was high within the Curatorial category (87% respondents), but lower in the Investigation and Research (69%) and Non-heritage (2 of the 4 respondents) categories, identifying another area of potential future training need.

Even though guidance documents have been written describing marine sediment recovery (notably Gribble and Leather 2011), over 50% of those who had heard of these approached (grabs and borehole / vibrocores) said that they didn't actually understand the different techniques available for this work. This suggests respondents were unaware of existent guidance documents (and other relevant texts) or else had not been able to engage with the existent written material.

Questions over marine geophysics clearly identified a gap in available knowledge over how raw data, derived from a survey, is handled prior to the interpretation phase. Respondents generally claimed to understand how data was acquisitioned and / or interpreted, but failed to understand the intermediate data processing stage. This knowledge gap should be seen as important in situations where an understanding of the dataset being interpreted (i.e. how the data was generated), or specification of how data is to be collected and delivered, for marine archaeological purposes is required. The recently published EH guidance document, authored by Plets, Dix and Bates (2013), should be circulated to a wider audience in the first instance to help bridge this knowledge gap, though specific training might also be desirable for practitioners to attend.

Sediment description is the best known, and most used, technique within the sediment analysis category, followed by particle size analysis. At the other end of the scale, the use of core scanners and stable isotope analysis is largely reliant upon the use of external specialists. Once again there appears to be more respondents using / commissioning these techniques than those who claim to be aware of sampling, material type and contamination issues. Therefore, once again, unless specialists (in house or external) are present when material is sampled, or those handing the raw material are suitably informed, the potential for sample contamination (and consequently aberrant results) may be high.

For the environmental archaeology techniques listed there was a clear focus upon traditional 'terrestrial' techniques such as macroscopic plant remains, pollen and spores and wood. Within the Curatorial category none of the respondents had commissioned assessment / analysis of diatoms, foraminifera or ostracods. Such techniques can provide key insights into past salinity conditions and the onset of marine conditions. The lower level of commissioning of these techniques tends to add support to the perception "*that marine archaeology is just terrestrial archaeology, though a bit wetter*".

In relation to dating techniques, similar knowledge gaps were identified, with c. 50% of those commissioning a technique also claiming to understand the associated dating limitation and contamination issues. There was also a strong bias toward dating techniques suitable for dating Holocene organic deposits (Radiocarbon and Dendrochronology) with OSL the only other frequently used (and understood) technique. Although OSL dating is particularly useful for pre-Holocene sequences (although radiocarbon dating can extend back to 50,000 years it does have notable potential contamination issues with dates older than c. 35,000; e.g. Briant and Bateman 2009), it should only be utilised when sample type (suitable quartz / feldspar aliquot availability and depositional environment), depositional environment and sampling / storage (must avoid light exposure) are suitable to yield a meaningful chronology. As a consequence, the survey demonstrates that insufficient knowledge, and application, still exists in relation to the dating of Pleistocene (pre-Holocene) sequences with archaeological potential, even though projects demonstrating this potential in an offshore context (e.g. Dix and Sturt 2011) were commissioned and reported under the former marine aggregates levy sustainability fund (MALSF). The dating of more recent sediments, using techniques such as short-lived isotopes, is also poorly understood. Recent deposits can be important for geoarchaeological investigations, such as sediment accumulation (and burial) of wreck sites. The least known technique listed was that of CND which has had a range of recent applications, including the dating of flint artefacts, and has been shown to be suitable for dating surface exposures (e.g. emergence of a coastal landscape from below sea-level) and burial dating (see Granger 2014). This technique has recently been highlighted for its potential applications in British archaeology (Milek and Jones 2012). Consequently, there is a need to better inform practitioners not only of the range of different techniques suitable for dating different material types, but also which are most suited for determining the age of materials from different archaeological periods.

7. Conclusions

There was a positive response (60%) to the suggestion of a training course at the University of Southampton, focused upon geoarchaeological techniques and methodologies using seabed and sub-seabed sediment samples obtained during geotechnical surveys. From the results of the survey it is

clear that there is no requirement to simply focus on generating a general awareness of different techniques (for which many respondents already have some baseline knowledge or relevant guidance documents / textbooks are available). Instead the major knowledge gaps exist in relation to sampling techniques, material type and contamination issues, ranging from initial sample collection to subsequent assessment / analysis investigations. There is a requirement to explain the wider use of existent techniques to answer questions beyond just submerged ancient terrestrial landscapes. Increased focus upon the interaction between marine and terrestrial conditions will help to contribute more fully to identifying both archaeological potential and palaeolandscape [and palaeogeography] change.

Much of the present knowledge is focused around working upon Holocene deposits (post-last Ice Age, last c. 11700 years) but approaches towards sediments of older Pleistocene (embracing the Palaeolithic archaeological record) sequences, particularly for establishing chronology, are less well understood. Therefore the provision of more guidance over dating techniques, for a range of different sedimentary environments highlighting likely contamination and sample handling procedures, is required. To ensure that the offshore archaeological record can benefit from the progress made with terrestrial sequences, utilising chronological modelling techniques (e.g. Whittle et al. 2011), it is essential that dating is undertaken both in a structured manner but also uses suitable techniques that can produce the most reliable date estimates.

Providing front-line practitioners / advisors with a greater knowledge base, helping them identify best practice, when to seek external advice, and highlighting new methodologies, is therefore a key priority. This will ensure that archaeological resources within the marine environment are dealt with in a proficient and cost-effective manner.

8. Training Recommendations

The market intelligence gathering has confirmed that there is a need for training in marine geoarchaeology to build external capacity in the workforce engaged in understanding, protecting and managing the historic environment. This training should be aligned along the production of, and wide distribution of, relevant guidance documentation and external training courses such as the one proposed within this project.

Based upon the survey results it is proposed that the training course, run by the University of Southampton, should be spread over two days with a focus upon the areas of most interest, and greatest training needs, highlighted in this report. A two day course would also incur a lower enrolment fee for attendees, as well as reducing other associated costs such as accommodation and full economic costing of employee attendance, all of which are necessary considerations when deciding whether relevant training (and Continuing Professional Development) opportunities can be funded. To enable the condensing of the training course into two days, pre-course material will be distributed to attendees. This will provide all attendees with a similar minimum baseline knowledge about the different techniques that will be discussed upon the course. This will mitigate the need to repeat information to attendees who already have a baseline understanding of some areas of [marine] geoarchaeology, allowing the course to focus more upon practical and discussion sessions.

The results of the survey also indicate a number of other training opportunities that should be explored for building relevant capacity in the historic environment:

- GIS software, particularly within the Investigation and Research category
- Marine Geophysics for Archaeological Purposes

An EH guidance document on dating techniques is currently being developed by the EH Scientific Dating team. Previous discussions with Alex Bayliss, head of the EH Scientific Dating team, have shown that there is an appetite for a discussion meeting between practitioners and dating experts over the use of scientific dating within an offshore context. This is confirmed through the findings from this survey. Consequently it would be beneficial to have a one day discussion meeting, provisionally entitled "scientific dating and its implications for sea level reconstructions", to be held, bringing together dating specialists, sea-level modellers and marine practitioners (especially those who have increased their knowledge base during the January 2015 Geoarchaeology training course). Such a meeting, which would likely take place after the NHPP programme has ended, could be arranged in collaboration with relevant interests groups, such as the Quaternary Research Association, Association of Environmental Archaeology, or Prehistoric Society, and could be hosted at the University of Southampton.

Finally, and along similar lines to knowledge of chronological methods, respondents with greater levels of experience and expertise noted that they would not require the core elements of a training course, but would welcome focused discussion on developing best practice and advancing methodologies. This represents an extension of the capacity building described by within this report but would be of direct benefit to the archaeological community. It is possible to envisage workshop days dedicated to addressing key archaeological questions relevant to offshore datasets and exploring the methods that could be adopted to answer them.

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Appendix A: Market Intelligence Research Survey Questions

1 Background information

The following questions will permit us to categories your responses based upon which sector you work within and how, in your role, you engage with the historic environment.

1.1 How would you describe **your job role**? Please select an overarching category followed by a more specific job role.

- Curatorial Roles (Historic Environment Services): Those who look after, in a management context, the historic environment
- Investigation and Research: Those who undertake invasive and non-invasive investigation for assessment recording and analysis on sites or assemblages produced from sites with archaeological interest.
- Non Heritage professional and practitioner: Those whose work bring them into regular contact with the historic environment and whose decision making may impact upon it

[If *Curatorial Roles*] Please select a job role within your chosen sector:

- Conservation Officer
- Archaeological Curator (County Archaeologist)
- Historic Environment Records Officer
- Consultant providing services to local authority
- Other

[If *Investigation and Research*] Please select a job role within your chosen sector:

- Archaeological Contractor
- Archaeological Specialist
- Surveyor / Engineer
- Researcher (University or Freelance)
- Museum Curator
- Other

[If *Non Heritage professional and practitioner*] Please select a job role within your chosen sector:

1.2 What is your current work status?

- Self-employed
- Part time employed
- Full-time employed
- Student
- Retired
- Unemployed

1.3 Are you involved with environmental assessment programmes for marine development projects?

- Yes / No

1.4 Please select which category best describes your organisation / employer

- Self-employed / Freelance
- Archaeological Unit
- Archaeological Consultancy
- Planning / Engineering Consultancy
- Geotechnical / Geophysical Survey Company
- Marine Infrastructure Developer
- University of other Academic Institute
- Museum
- Non-Government Organisation
- Local Government
- Non-Departmental Public Body
- Other Government Department
- Other

1.5 Is your organisation's primary focus upon archaeology / heritage?

- Yes / No

1.6 Approximately how many archaeological / heritage staff (full or part-time contracted staff) are employed in your organisation?

- None
- 1
- 2 to 5
- 6 to 10
- 11 to 20
- 21 to 50
- 51 to 100
- 101+

[*If the answer is 1 or greater*] How many of these staff would you consider have specialist skills in environmental archaeology or geoarchaeology (including marine geophysics for archaeological purposes)?

- None
- 1 to 2
- 3 to 5
- 6 to 10
- 11+

2 Provision of Marine Geoarchaeological Specialisms

Geoarchaeology is the application of earth science principles and techniques to the understanding of the archaeological record. This can include investigations into the type, and nature, of sediments and, typically, biological remains within them, as well as establishing the age of the deposits. Geoarchaeological approaches can assist many levels of archaeological enquiry, and can be used for prospection, understanding site formation processes, explaining issues of preservation, refining interpretations of archaeological contexts and identifying changes in the physical landscape through time.

2.1 Did you know that geotechnical materials (e.g. boreholes, grab samples) are important for archaeological purposes?

- Yes / No

2.2 Did you know that marine geophysics is an important technique in marine geoarchaeology?

- Yes / No

2.3 A series of guidance documents are available and provide information that is relevant to marine geoarchaeological studies:

Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector (2011: Gribble and Leather; published by COWRIE Ltd).

Marine Geophysics Data Acquisition Processing and Interpretation: guidance notes (2013: Plets, Dix and Bates. Published by English Heritage).

Geoarchaeology: Using earth sciences to understand the archaeological record (2007: Ayala, Canti, Heathcote, Sidell and Usai; published by English Heritage).

Environmental Archaeology. A Guide to the Theory and Practice of Methods from Sampling and Recovery to Post-excavation (2011: Campbell, Moffett and Straker. Published by English Heritage)

Have you ever read any of these guidance documents?

- Yes / No

[*If Yes*] Would you like to comment on any of these guidance documents?

2.4 Would you regard yourself as a geoarchaeologist / environmental archaeologist?

- Yes / No

[*If Yes*] Please indicate your highest level of formal qualification:

- School qualification (GCSE A-Level or equivalent)
- Foundation degree or Higher National Diploma
- Undergraduate degree
- Postgraduate degree
- Doctorate degree

[*If Yes*] How many years' experience do you have in the field of geoarchaeology / environmental archaeology?

- 1 to 2
- 3 to 5
- 6 to 10
- 11 to 20
- 21+

2.5 Please select which of the following statements is most applicable to you:

- I have some knowledge of the techniques and methods available to archaeologists / geoarchaeologists
- I have NO knowledge of the techniques and methods available to archaeologists / geoarchaeologists

[If the response if "I have NO knowledge" the respondent will miss sections 4 to 8]

3 Training requirements

This section provides you with an opportunity to identify any current training requirements, within the field of marine geoarchaeology, which you may have.

3.1 Have you ever received training in geoarchaeology, environmental archaeology or geochronology?

- *Yes / No*

3.2 What training would you personally like to receive in the field of Marine Geoarchaeology?

- *Formal Qualification (e.g. diploma or degree)*
- *Short course (external to your organisation)*
- *Short course (internal training within your organisation)*
- *Online training*
- *Discussion seminar*
- *Guidance documents*
- *No training*
- *Other*

3.3 Do you feel your organisation (or yourself if self-employed) would fund attendance for any of the following training?

- *Formal Qualification: Yes / No*
- *Short course (external to your organisation): Yes / No*
- *Short course (internal training within your organisation): Yes / No*
- *Online training: Yes / No*
- *Discussion seminar: Yes / No*

3.4 As part of the NHPP 6205 project the University of Southampton, in partnership with English Heritage, will be running a three day training course in January 2015. This will focus on geoarchaeological techniques and methodologies using seabed and sub-seabed sediment samples obtained during geotechnical surveys. Would you be interested in attending this training event?

- *Yes / No*

4 Geoarchaeological Components: Desk Based Studies

A range of different desk-based studies can be undertaken for marine geoarchaeological purposes. Using your past experience, as well as any training you may have received, please indicate which approaches you have heard of, whether you feel sufficiently confident to undertake the work for a marine geoarchaeological project, and whether there is currently such capability within your organisation.

4.1 Please tick the relevant statement(s) against each listed technique

	Confident in technique (including sourcing data)?	**Capacity within your organisation for this assessment?**	**Use an external specialist to carry out this work?**
Survey planning, including marine geotechnical sampling strategy			
Sediment deposit modelling for buried and submerged landscape features			
Production of technical geoarchaeological report			

4.2 Do you use GIS software in your workplace?

- Yes / No

[*If yes*] Please provide the name(s) of the software that you have available.

5 Geoarchaeological Components: Prospecting and Sampling

A range of techniques are available for obtaining material / data for marine geoarchaeological purposes. Using your experience, as well as any training you may have received, please indicate your personal level of understanding of each stated technique.

5.1 Please tick the relevant statement(s) against each listed technique

	Heard of this method?	**Understand different techniques available**	**Used method for archaeological purposes?**
Marine sediment recovery: grab samples			
Marine sediment recovery: boreholes and vibrocores			
Marine Geophysics			

5.2 For Marine Geophysics, please indicate if you have expertise in working with any of the following techniques

	Data acquisition	**Processing**	**Interpretation**	**N/A**
Bathymetric survey				
Sub-bottom profiler survey				
Side scan sonar survey				
Magnetometer survey				

6 Geoarchaeological Components: Sediment Analysis

A range of techniques are available for describing and analysing sediments for marine geoarchaeological purposes. Using your past experience of both terrestrial and / or marine archaeology, as well as any training you may have received, please indicate your personal level of understanding and utilisation of each stated technique.

6.1 Please tick the relevant statement(s) against each listed technique

	Heard of this method?	Aware of sampling, material type and contamination issues?	Capability within your organisation?	Use external specialist for this technique?	Used this technique during offshore studies?
Sediment description					
Soil micromorphology					
Particle size analysis					
Core scanning (e.g. magnetic susceptibility, X-ray; trace element analysis)					
Stable isotope analysis					

7 Geoarchaeological Components: Environmental Archaeology

A range of environmental archaeology techniques are available for describing and analysing the organic components of sediments for marine geoarchaeological purposes. Using your past experience of both terrestrial and / or marine archaeology, as well as any training you may have received, please indicate your personal level of understanding and utilisation of each stated technique.

7.1 Please tick the relevant statement(s) against each listed technique

	Heard of this method?	Aware of sampling, material type and contamination issues?	Capability within your organisation?	Use external specialist for this technique?	Used this technique during offshore studies?
Macroscopic plant remains					
Charred plant material and charcoal					
Wood					
Pollen and spores					
Diatoms					
Insects					
Chironomids					
Foraminifera					
Molluscs					
Ostracods					
Vertebrate remains / animal bone					

8 Geoarchaeological Components: Chronology

A range of techniques are available for determining the age of sediments for geoarchaeological purposes. Using your past experience of both terrestrial and / or marine archaeology, as well as any training you may have received, please indicate your personal level of understanding and utilisation of each stated technique.

7.1 Please tick the relevant statement(s) against each listed technique

	Heard of this method?	**Aware of sampling, material type and contamination issues?**	**Used this method?**	**Used this method during offshore studies?**
Radiocarbon				
Uranium-Series Dating				
Short-lived Isotopes				
Cosmogenic Nuclide Dating				
Optically Stimulated Luminescence				
Electron Spin Resonance				
Amino Acid Racemisation				
Tephrochronology				
Dendrochronology				
Palaeomagnetism				
Chronological models (e.g. age-depth models; Bayesian statistics)				

9 Final comments

9.1 Would you like to contribute any additional comments to this survey?

Appendix B: Section 4 Results by Job Category. Geoarchaeological Components: Desk Based Studies

	Curatorial	Investigation and Research	Non Heritage professional	Total
Survey planning, including marine geotechnical sampling strategy				
Confident in technique (including sourcing data)?	3	9	0	12
Capacity within your organisation for this assessment?	3	19	1	23
Use an external specialist to carry out this work?	10	15	2	27
Sediment deposit modelling for buried and submerged landscape features				
Confident in technique (including sourcing data)?	1	6	0	7
Capacity within your organisation for this assessment?	2	19	1	22
Use an external specialist to carry out this work?	12	16	2	30
Production of technical geoarchaeological report				
Confident in technique (including sourcing data)?	1	11	0	12
Capacity within your organisation for this assessment?	2	19	0	21
Use an external specialist to carry out this work?	12	13	3	28

Appendix C: Section 5 Results by Job Category. Geoarchaeological Components: Prospecting and Sampling

	Curatorial	Investigation and Research	Non Heritage professional	Total
Marine sediment recovery: grab samples				
Heard of this method?	10	39	2	51
Understand different techniques available	5	19	0	24
Used method for archaeological purposes?	2	12	2	16
Marine sediment recovery: boreholes and vibrocores				
Heard of this method?	11	40	2	53
Understand different techniques available	6	18	0	24
Used method for archaeological purposes?	3	17	2	22
Marine geophysics				
Heard of this method?	11	40	2	53
Understand different techniques available	7	16	0	23
Used method for archaeological purposes?	3	16	2	21

	Curatorial	Investigation and Research	Non Heritage professional	Total
Bathymetric survey				
Data acquisition	1	11	2	14
Processing	0	8	0	8
Interpretation	4	13	1	18
Full process	0	7	0	7
Sub-bottom profiler survey				
Data acquisition	0	9	2	11
Processing	0	7	0	7
Interpretation	4	10	1	15
Full process	0	6	0	6
Side scan survey				
Data acquisition	2	10	2	14
Processing	1	9	0	10
Interpretation	4	13	1	18
Full process	0	8	0	8
Magnetometer survey				
Data acquisition	0	8	2	10
Processing	1	8	0	9
Interpretation	5	14	1	20
Full process	0	5	0	5

Appendix D: Section 6 Results by Job Category. Geoarchaeological Components: Sediment Analysis Results

	Curatorial	Investigation and Research	Non Heritage professional	Total
Sediment description				
Heard of this method?	13	42	2	57
Aware of sampling, material type and contamination issues?	6	20	0	26
Capability within your organisation?	2	25	0	27
Use external specialist for this technique?	5	5	1	11
Used this technique during offshore studies?	2	11	1	14
Soil micromorphology				
Heard of this method?	12	40	2	54
Aware of sampling, material type and contamination issues?	5	17	0	22
Capability within your organisation?	2	11	0	13
Use external specialist for this technique?	7	17	2	26
Used this technique during offshore studies?	1	3	0	4
Particle size analysis				
Heard of this method?	11	41	2	54
Aware of sampling, material type and contamination issues?	4	19	0	23
Capability within your organisation?	3	16	0	19
Use external specialist for this technique?	5	12	1	18
Used this technique during offshore studies?	2	6	1	9
Core scanners (e.g. magnetic susceptibility, X-ray, trace elements analysis)				
Heard of this method?	11	38	2	51
Aware of sampling, material type and contamination issues?	6	14	0	20
Capability within your organisation?	1	6	0	7
Use external specialist for this technique?	5	16	2	23
Used this technique during offshore studies?	1	5	0	6

	Curatorial	Investigation and Research	Non Heritage professional	Total
Stable isotope analysis				
Heard of this method?	13	41	2	56
Aware of sampling, material type and contamination issues?	7	18	0	25
Capability within your organisation?	1	7	0	8
Use external specialist for this technique?	6	20	2	28
Used this technique during offshore studies?	0	3	0	3

Appendix E: Section 7 Results by Job Category. Geoarchaeological Components: Environmental Archaeology

	Curatorial	Investigation and Research	Non Heritage professional	Total
Macroscopic plant remains				
Heard of the method?	13	42	2	57
Aware of sampling, material type and contamination issues?	9	22	0	31
Capability within your organisation?	2	24	0	26
Use external specialist for this technique?	7	8	2	17
Used this technique for offshore studies?	2	8	0	10
Charred plant remains and charcoal				
Heard of the method?	12	42	2	56
Aware of sampling, material type and contamination issues?	9	22	0	31
Capability within your organisation?	1	22	0	23
Use external specialist for this technique?	8	9	2	19
Used this technique for offshore studies?	2	9	0	11
Wood				
Heard of the method?	12	42	2	56
Aware of sampling, material type and contamination issues?	9	23	0	32
Capability within your organisation?	1	24	0	25
Use external specialist for this technique?	8	10	2	20
Used this technique for offshore studies?	2	9	0	11
Pollen and spores				
Heard of the method?	12	42	2	56
Aware of sampling, material type and contamination issues?	9	19	0	28
Capability within your organisation?	1	20	0	21
Use external specialist for this technique?	8	11	2	21
Used this technique for offshore studies?	2	10	0	12

	Curatorial	Investigation and Research	Non Heritage professional	Total
Diatoms				
Heard of the method?	13	42	2	57
Aware of sampling, material type and contamination issues?	8	19	0	27
Capability within your organisation?	1	10	0	11
Use external specialist for this technique?	8	18	2	28
Used this technique for offshore studies?	0	9	0	9
Insects				
Heard of the method?	13	43	2	58
Aware of sampling, material type and contamination issues?	9	21	0	30
Capability within your organisation?	1	10	0	11
Use external specialist for this technique?	9	19	2	30
Used this technique for offshore studies?	0	7	0	7
Chironomids				
Heard of the method?	9	37	2	48
Aware of sampling, material type and contamination issues?	4	17	0	21
Capability within your organisation?	1	5	0	6
Use external specialist for this technique?	5	18	2	25
Used this technique for offshore studies?	0	3	0	3
Molluscs				
Heard of the method?	13	42	2	57
Aware of sampling, material type and contamination issues?	8	19	0	27
Capability within your organisation?	1	19	0	20
Use external specialist for this technique?	8	10	1	19
Used this technique for offshore studies?	1	9	1	11

	Curatorial	Investigation and Research	Non Heritage professional	Total
Foraminifera				
Heard of the method?	12	41	2	55
Aware of sampling, material type and contamination issues?	6	20	0	26
Capability within your organisation?	1	13	0	14
Use external specialist for this technique?	6	14	2	22
Used this technique for offshore studies?	0	7	0	7
Ostracods				
Heard of the method?	10	39	2	51
Aware of sampling, material type and contamination issues?	7	19	0	26
Capability within your organisation?	1	11	0	12
Use external specialist for this technique?	8	14	2	24
Used this technique for offshore studies?	0	6	0	6
Vertebrate remains / animal bone				
Heard of the method?	13	42	2	57
Aware of sampling, material type and contamination issues?	9	21	0	30
Capability within your organisation?	1	22	0	23
Use external specialist for this technique?	9	9	2	20
Used this technique for offshore studies?	0	8	0	8

Appendix F: Section 8 Results by Job Category. Geoarchaeological Components: Chronology

	Curatorial	Investigation and Research	Non Heritage professional	Total
Radiocarbon dating				
Heard of the method?	13	42	2	57
Aware of sampling, material type, age-range and contamination issues)?	9	25	1	35
Used this method?	8	24	1	33
Aware AND Used	4	13	0	17
Used this method during offshore studies?	2	9	1	12
Uranium-series dating				
Heard of the method?	10	36	2	48
Aware of sampling, material type, age-range and contamination issues)?	3	17	0	20
Used this method?	0	4	0	4
Aware AND Used	0	3	0	3
Used this method during offshore studies?	0	0	0	0
Short-lived isotopes (e.g. Caesium-137, Lead-210)				
Heard of the method?	9	34	2	45
Aware of sampling, material type, age-range and contamination issues)?	2	13	0	15
Used this method?	1	4	0	5
Aware AND Used	0	3	0	3
Used this method during offshore studies?	1	1	0	2
Cosmogenic nuclide dating				
Heard of the method?	5	18	2	25
Aware of sampling, material type, age-range and contamination issues)?	2	6	0	8
Used this method?	0	2	0	2
Aware AND Used	0	2	0	2
Used this method during offshore studies?	0	0	0	0

	Curatorial	Investigation and Research	Non Heritage professional	Total
Optically stimulated luminescence				
Heard of the method?	11	36	2	49
Aware of sampling, material type, age-range and contamination issues)?	7	19	0	26
Used this method?	4	14	1	19
Aware AND Used	2	9	0	11
Used this method during offshore studies?	1	8	0	9
Electron spin resonance				
Heard of the method?	5	35	1	41
Aware of sampling, material type, age-range and contamination issues)?	3	12	0	15
Used this method?	1	2	0	3
Aware AND Used	0	2	0	2
Used this method during offshore studies?	0	1	0	1
Amino acid racemisation				
Heard of the method?	7	33	1	41
Aware of sampling, material type, age-range and contamination issues)?	3	13	0	16
Used this method?	0	4	0	4
Aware AND Used	0	3	0	3
Used this method during offshore studies?	0	1	0	1
Tephrochronology				
Heard of the method?	7	31	1	39
Aware of sampling, material type, age-range and contamination issues)?	3	15	0	18
Used this method?	3	3	0	6
Aware AND Used	1	2	0	3
Used this method during offshore studies?	1	0	0	1
Dendrochronology				
Heard of the method?	13	41	2	56
Aware of sampling, material type, age-range and contamination issues)?	10	26	0	36
Used this method?	8	13	1	22
Aware AND Used	5	8	0	13
Used this method during offshore studies?	0	3	1	4

	Curatorial	Investigation and Research	Non Heritage Professional	Total
Palaeomagnetism				
Heard of the method?	11	31	2	44
Aware of sampling, material type, age-range and contamination issues)?	6	16	0	22
Used this method?	4	3	0	7
Aware AND Used	2	2	0	4
Used this method during offshore studies?	0	1	0	1
Chronological models (e.g. age-depth models; Bayesian statistics)				
Heard of the method?	12	35	2	49
Aware of sampling, material type, age-range and contamination issues)?	5	15	0	20
Used this method?	5	10	0	15
Aware AND Used	3	5	0	8
Used this method during offshore studies?	0	3	0	3