Cyfoeth Naturiol Cymru
Natural Resources Wales

Guidance Note

Benthic habitat assessment guidance for marine developments and activities

A guide to subtidal habitat characterisation surveys

Reference number: GN030g

Document Owner: Marine Programme Planning and Delivery Group

What is this document about?

This guidance sets out our methods and approaches for subtidal habitat characterisation surveys where such work is required to support environmental and ecological impact assessments for developments and activities in or near Welsh waters.

Who is this document for?

This is best practice technical guidance for developers designing marine benthic habitat surveys and monitoring in relation to maritime developments.

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Version History

Document Version	Date Published	Summary of Changes
1.0	[01-2020]	Document published
2.0	[02-2021]	Revision after 1 year of publication

Review Date: [02-2022]

To report issues or problems with this guidance contact Guidance Development

Contents

1. Introduction and summary

This guidance document is one of a series of Benthic Habitat Assessment Chapters developed by Natural Resources Wales (NRW) for key habitats of conservation importance around Wales. It has been prepared by NRW with the initial technical information prepared under contract by APEM Ltd and Ocean Ecology Limited.

The guidance series aims to assist developers in designing and undertaking robust benthic habitat characterisation surveys and monitoring of these habitats in the context of Ecological Impact Assessment, thereby helping streamline the regulatory review and consultation process.

This chapter focuses on the characterisation of subtidal seabed habitats. It will be relevant if you need to carry out a seabed habitat characterisation survey and:

- You have no seabed habitat data, or
- You have limited seabed habitat data that you need to improve

If you already have seabed habitat data and need to carry out more specific surveys of particular habitats and/or design monitoring surveys of those habitats, refer to the following chapters of the guidance. Currently there is not a specific chapter of the guidance for subtidal rocky habitats. This may be covered in a future chapter of the guidance. However, the chapters listed here provide details on a number of survey methods that are also applicable to subtidal rocky habitats:

- Subtidal sediments (GN030h)
- Horse mussel *Modiolus modiolus* (GN030c)
- *Sabellaria* reef (GN030d)
- Seagrass beds (GN030f)

This habitat chapter (GN030g) is not intended to be used alone and should always be used in conjunction with the NRW Guidance Note GN030 (overarching guidance note) and the Introductory chapter (GN030-intro).

2. Survey design

Where developments and activities may influence benthic marine habitats, information about the habitats present will often be required. This includes:

- Developments or activities of a nature and scale requiring formal Environmental Impact Assessment (EIA) under EIA regulations;
- Smaller projects that fall outside of the formal EIA requirements, but where ecological information needs to be provided by the developer to the licensing authority as part of the consenting process.

Marine benthic habitat surveys may be required in order to support your application and to satisfy any subsequent licence conditions. This guidance will help you fulfil any requirements on you to undertake such surveys, and it will help us assess proposals for such work. The aim of benthic habitat characterisation is to be able to accurately describe the habitats that may be impacted by a development or activity, with particular reference to habitats that may be of conservation importance (see section 4.4). This information is then used alongside other information (e.g. evidence on habitat sensitivity and information on the potential pressures from the development or activity) to assess the possible ecological impacts of the development.

You can find more information about when and why habitat characterisation may be required in Guidance Note GN030 and in section 3 of introductory chapter GN030 – intro.

Key considerations for the design of a subtidal habitat characterisation survey are explained in the Introductory Chapter GN030-intro (section 3), they include:

- The details of your proposed development or activity, the pressures arising from it, the habitats that may be impacted and the importance of identifying the spatial area (Zone of Influence (ZoI)) that may be affected.
- Whether the proposed works are within or likely to affect a marine protected area or protected habitats.
- Whether the proposed works or Zone of Influence are within a Water Framework Directive water body.
- The availability of existing habitat information (presence, extent, distribution) and confidence in that data.
- The objectives of your survey.

Refer to section 2.1 of the Introductory Chapter for more detail about the sort of information and level of detail that NRW would expect for a habitat characterisation survey proposal.

2.1. Existing data

There may already be some habitat information available for the zone of influence. A comprehensive desk-based review of all available data relevant to subtidal habitats within the area of interest should be conducted prior to designing any habitat characterisation surveys.
You can find information on available datasets and how to access them in:

- GN006 Marine ecology datasets for marine developments and activities.

You can find information on sourcing and using data in:

- JNCC: Report 598 Monitoring guidance for marine benthic habitats (Noble-James et al. (2017).
- GN030-intro Benthic habitat assessment guidance for marine developments and activities, introductory chapter.

2.2. Survey options

The outputs required from a benthic characterisation survey will vary according to the scale and nature of the proposed development. As a minimum, for any project requiring Environmental Impact Assessment (EIA), or any project that might impact a protected site, we would expect a seabed habitat map showing:

- The different species assemblages recorded (seabed habitat/community types) generally using the Joint Nature Conservation Committee (JNCC, 2015) or European Nature Information System (EUNIS) biotope classification (to level 3 of the EUNIS classification, although levels 4 or 5 would be preferred).
- Any areas of protected habitats or records of protected species (for example, Habitats Directive Annex I habitats and protected benthic epibiotic and infaunal species (such as those listed under Section 7 of the Environment (Wales) Act 2016 or on the OSPAR list of threatened and/or declining species and habitats)).
- The location and extent of the proposed development and the Zone of Influence, in relation to the seabed habitats and any protected habitats/species and Water Framework Directive water bodies.

Survey methods need to be determined on a project by project basis. You need to take into account known or potential presence of habitats and species of conservation importance, the sensitivity, and the likely scale of impact. There are various options for your subtidal habitat characterisation survey depending on available information and the nature and scale of your development.

- Geophysical survey: This is likely to be required for large-scale developments (e.g. those requiring EIA) in order to provide up to date information on the subtidal habitats within the Zone of Influence. It may also be required for some smaller-scale developments if they are likely to affect a particular protected habitat or have the potential to cause indirect impact over a wider area.

  Geophysical data needs to be ground-truthed using other survey methods in order to confirm the habitats or biotopes that are present and their extent and distribution. The choice of ground-truthing survey method will depend on the habitat present as indicated by the geophysical data (section 4).
- Non-geophysical survey methods: Other survey approaches, such as use of drop-down cameras and video, grab sampling and diver surveys may be sufficient for a habitat characterisation survey (for example, for smaller-scale developments with a restricted footprint of likely effects).

These methods are also commonly used for ground-truthing geophysical data and for more detailed sampling within habitats to obtain more specific information about the habitat and its species assemblage.

The main geophysical survey methods for subtidal habitat characterisation are described in section 3. Other survey methods (including those commonly used for ground-truthing) are presented in section 4.

Guidance for habitat characterisation survey design is also provided in Davies *et al.*(2001), Ware & Kenny (2011) and Noble-James *et al.*(2017).

3. Geophysical Survey methods

Geophysical surveys can map the extent and distribution of subtidal habitats based on topographic features (such as rock outcrops and ridges, sand waves and sand banks) and topographic complexity. Topographic complexity refers to the diversity and arrangement of three-dimensional structural elements over the seabed surface, such as presence of biogenic reefs, exists on all spatial scales and contributes significantly to the ecological function of a given community. Geophysical surveys can be used to assign seabed sediments to broad categories such as sands, cobbles and boulders, or bedrock, especially where the boundaries of these substrates is distinct.

They can also be used to identify certain habitats of conservation importance, in particular biogenic reefs such as horse mussel *Modiolus modiolus* reefs and *Sabellaria spinulosa* reefs.

Geophysical surveys alone cannot define seabed habitats. The geophysical data can be used to identify, and create a map of, different sediment facies but this needs to be ground-truthed with biological surveys to confirm the habitats or biotopes present and their extent and distribution.

3.1. Survey design

Geophysical survey needs to provide sufficient coverage of the target survey area(s) (for example, both the primary and secondary impact zones).

Where geophysical survey is also required to inform the construction methodology for a development, it may be beneficial and more cost effective to address this and the requirement for habitat characterisation at the same time. Early dialogue between the geophysical surveyors and the benthic ecology advisors will be needed to ensure that the geophysical survey is suitable for collecting benthic ecology information.

For a large development, NRW would generally expect both multibeam and side scan data to be collected. This should conform to International Hydrographic Organisation (IHO) standards (S44 and S57) and have regard for the guidance provided in relevant MESH Recommended Operating Guidelines (ROGs) (such as Coggan *et al.*, 2007; Hopkins, 2007; Henriques *et al.,* 2012). The MESH guide to marine habitat mapping provides general guidance on seabed mapping. For smaller developments where geophysical data is required, one of either multibeam or sidescan may be appropriate. In these circumstances either technique is generally valid, although where biogenic structures or stony reef is expected, side scan may be marginally preferable. For developments with a very small footprint, geophysical surveys may not be required.
There are important considerations for the interpretation of acoustic data which are explained in section 3.3.

Geophysical methods other than side scan sonar and multibeam described below may be relevant for specific habitats and in certain situations, such as use of Digital Image Scanning Sonar for *Sabellaria* reef surveys in turbid conditions. These are covered in the habitat-specific chapters of the guidance where appropriate.

3.2. Geophysical survey methods

3.2.1. Side scan sonar

Side scan sonar uses narrow beams of acoustic energy, transmitting them across the seabed and recording the intensity of the reflected signal. Side scan is particularly effective at discriminating features on the surface of the seafloor. Analysis of the sonar data allows prominent seafloor features to be determined and helps to discriminate between different substrates, depending on the quality and resolution of the sonar data. However, it cannot necessarily differentiate between fine and coarse sands. Some anthropogenic features such as trawl marks are visible in side scan sonar imagery.

Harder areas (such as coarser substrates like boulders and bedrock reef) are areas of high reflectivity. They reflect more energy (high backscatter) and usually appear as a lighter signal on the image. Areas of low reflectivity (for example, softer substrates such as fine sands) reflect less energy (low backscatter) and appear as a darker signal. Very dark areas normally mean the absence of backscattered sound, indicating a shadow behind objects. Further information related to the interpretation of backscatter is provided in Henriques *et al*. (2012).

Side scan sonars are characterised by a beam which is narrow in the horizontal plane and wide in the vertical plane. This creates a narrow acoustic sweep across the sea bed at right angles to the track of the towfish (the unit holding the sonar). Side scan sonars are available with frequencies ranging from about 5 kHz to 1 mHz. Lower frequencies provide a longer range with lower resolution whilst the higher frequencies have a higher resolution but a shorter range (for example, 5 kHz system can have range of >50 km, while for 1 mHz system the range may be just 50 m) (Henriques *et al*. 2012). For benthic habitat mapping, short ranges are used (100 m or less), which allow relatively small features to be detected (Long 2005)

For habitat mapping, side scan sonar may be deployed within a suite of complimentary survey methods including multibeam echo sounders to provide a georeferenced morphology over which high-resolution side scan mosaics can be draped (Henriques *et al*. 2012).

The height of the towfish above the seabed should be between 5 and 10% of the horizontal range setting. This usually allows a good level of seabed feature discrimination, including detection of some biogenic reef features. The overlap between tracks should be at least 50% and include appropriate cross tracks. Where complete seabed coverage is required for detailed feature or habitat mapping, 200% coverage is recommended.

3.2.2. Multibeam echo sounders

Multibeam data provides a detailed bathymetric dataset for the survey area, allowing features such as undulations and sand ripples to be detected. Multibeam echo sounders (MBES) determine depth by accurately measuring the angles of emission, reception and two-way travel time for a pulse of sound energy from the emitting instrument (transducer) to the seabed and back.

A key benefit of MBES is its ability to simultaneously collect bathymetry and backscatter information in a single survey. The images obtained can be used to map the different acoustic characteristics of the seafloor, which can then be used to characterise seabed material when accompanied with ground-truthing and/or following input to acoustic classification software. MBES systems can achieve 100% bottom coverage with beam swath widths of four to seven times the depth of water being surveyed. Guidance for the use of multibeam is provided in the MESH swath bathymetry ROG (Hopkins, 2007). Multibeam data can also be useful for other purposes, for example, informing hydrodynamic models and construction methodologies.

When collecting multibeam data, it is important to maintain an appropriate overlap to ensure that 100% coverage is achieved without any data gaps or holes. Appropriate statistical analysis of cross line and main line intersections should be undertaken to assess the quality of the data.

3.3. Geophysical data analysis and quality control

Processing of acoustic data can be complex and vary markedly depending on the method of collection. A variety of guidance is available (Henriques *et al.*, 2012; IMCA, 2015) and should be followed where possible. All processing should meet International Hydrographic Organisation 1A standard (IHO 2008).

Multibeam and side scan data should be analysed by someone experienced in interpretation of such data in relation to biological habitats. Particular attention needs to be given to the possible presence of biogenic habitats. Useful information regarding acoustic signals from *Modiolus modiolus* reefs and *Sabellaria spinulosa* reefs can be found in Lindenbaum *et al*. (2008), Jenkins *et al*. (2018) and Pearce *et al*. (2014). However, the *Modiolus modiolus* reef that is the subject of the paper by Lindenbaum *et al* (2008) is particularly distinct in terms of its morphology; *Modiolus modiolus* reefs in other areas within Welsh waters (such as the north and west of Anglesey) have a far less distinct acoustic signature. Chapters GN030c (*Modiolus* reefs) and GN030d (*Sabellaria* reefs) provide more detail about these biogenic reef habitats and acoustic signals.

The scale at which the data is examined is important. If the multibeam bathymetry or side scan data is viewed at too small a scale, then biogenic features may be missed. It is therefore important to view the data at a range of scales; for example, scales of between 1:4,000 and 1:2,000 have previously been found to be appropriate for delineating biogenic *Modiolus modiolus* reefs from side scan data depending on their distinctiveness from the surrounding seabed. A scale of 1:2,000 allows a 300m square to be displayed comfortably on an average computer screen. It is advisable to look at the data at more than one scale, for example at a scale of both 1:4,000 and 1:2,000. This means that the resolution of the data also needs to be appropriate so that fine detail used for habitat discrimination isn’t lost.

The data processing routines of converting the raw sounding data to the final sounding values are critical in producing quality bathymetric data from which biological habitats can be discriminated. Any methods used to derive final depths such as cleaning filters, sounding suppression/data decimation, binning parameters should be done sensitively, bearing in mind the importance of the sediment surface features. The methods should be documented and presented in any survey reports.

3.3.1. Side scan sonar

Side scan sonar data can be processed in real-time to provide field surveyors with composite mosaics. This is suitable for initial quality control and preliminary on-board interpretation. However, like MBES-derived data, side scan sonars are susceptible to interferences from a number of sources (e.g. vessel noise), so the recorded raw data should be processed after collection before attempting to classify seabed habitats.

3.3.2. Multibeam echo sounders

The data collected from MBES systems are complex given that they can provide 100% bottom coverage and require a great deal of post-processing to apply positional, tidal and sound velocity corrections before meaningful interpretations can be made (see IMCA, 2015). Tidal information must be incorporated at the post-processing stage in order to correct all soundings to a standard tidal datum. Additional data cleaning and checking may be required in regard to vessel navigation data.

Standard data-processing for MBES data will involve building a digital terrain model (DTM) This can be visualized in a variety of software packages and imported into Geographic Information Systems (GIS) where it can be integrated with additional biological and geophysical datasets. Unlike data derived from single beam echo sounders, the DTM outputs are normally continuous (as long as 100 % coverage is achieved).

MBES data should be gridded at a suitable resolution that will enable accurate bathymetric mapping (1m would generally be suitable, although a higher resolution may be required if the aim is to detect specific small features). Where appropriate, shaded relief models may be created based upon the bathymetric outputs and the two can be overlain to provide additional information.

The MBES outputs should be compared alongside the side scan sonar to identify sediment type and other features of interest where possible, and to confirm seabed morphologies, which can include identification of bedrock, boulders and boulder fields, sand waves and biogenic reef.

4. Non-geophysical subtidal habitat survey

This section briefly describes other survey methods that can be used on their own for subtidal habitat characterisation survey and/or to ground-truth geophysical survey. Most of these methods are covered in more detail in other chapters of the guidance (Table 1).

4.1. Survey design in the absence of geophysical survey

If methods other than geophysical survey approaches are to be used on their own for a subtidal habitat characterisation survey, consideration needs to be given to how they will be most effectively deployed to obtain the necessary information to describe the subtidal habitats within the survey area and zone of influence. The survey design will depend on whether there is any existing information to inform the survey approach. Further information about survey design is given in the Introductory Chapter GN030-intro Section 3.2. Refer also to other chapters of this guidance, as indicated in Table 1, for further detail in relation to particular seabed habitats.

4.2. Survey design for ground-truth survey

Information from the geophysical survey will inform the selection of sampling sites for the ground truthing survey. Sampling should be representative, to ensure that all different ground types are sampled and that each ground type has a similar amount of sampling.

A ground truthing survey needs to collect the physical and biological information necessary to validate the geophysical survey in order to:

- Assign a habitat/biotope class to the ground types/mapped areas, In general using the Joint Nature Conservation Committee (JNCC, 2015) or European Nature Information System (EUNIS) biotope classification (to level 3 of the EUNIS classification, although levels 4 or 5 would be preferred) (see section 3.2.4 of the Introductory Chapter GN030-intro for more information about these classifications).
- Validate the nature and location of borders between ground-types.

If a particular habitat/biotope classification scheme is to be used, the ground truth sampling needs to record the parameters relevant to that scheme so the samples or observations can be matched with the appropriate habitat definitions. Where an existing classification is not being applied, a variety of physical and biological parameters should be recorded consistently across the survey area to allow habitat classes to be determined.

The number of sample stations should be sufficient to cover the range of habitat types within the potential Zone of Influence, with sufficient replication of sample stations to cover all the areas of interest. The number of samples required will depend in part on the variability of the habitats to be surveyed; an increased number of sample stations is recommended for non-uniform habitats (Ware & Kenny 2011). The survey approach needs to consider if sampling needs to be stratified to account for environmental variables.

Within-station replication of samples can provide a better understanding of small-scale variability within a habitat/species community and is useful if this is a requirement of the survey. However, for a habitat characterisation survey it will, in general, be more beneficial to collect single samples from a wider range of locations than collect within-station replicates, particularly where resources are limited (Holtrop & Brewer, 2013).

The biological survey results should be cross-checked with any initial sediment map to see whether the seabed types found in the biological survey are consistent. If they are not, reinterpretation of the data underlying the sediment map may be required. Further information can be found in Ware & Kenny (2011). Guidance on ground truth survey strategy and design is provided in the MESH Guide to Habitat Mapping.

4.3. Survey methods

The sampling method needs to be appropriate to the anticipated ground type (for example, sediment, rock, biogenic reef), the survey conditions (such a depth, tidal currents, turbidity) and the specific data required from the survey.

Many sampling techniques can provide information on both physical and biological aspects of the habitat. Consideration should be given to the options within a particular method to ensure it is the most relevant to the survey (for example, the type of grab used depending on whether sediment is coarse or fine). Commonly used methods are summarised in Table 1 with reference to other chapters of this guidance where further guidance on the methods is provided.

Particular care should be exercised if biogenic reef habitats (such as horse mussel *Modiolus modiolus* reefs or *Sabellaria* reefs) or seagrass are possibly present. Grabs, trawls, dredges and other towed survey equipment have the potential to damage these habitats. Alternative methods should be used where these habitats are present or considered likely to be present. See specific habitat chapters for more information:

- Horse mussel *Modiolus modiolus* (GN030c)
- *Sabellaria* reef (GN030d)
- Seagrass beds (GN030f)

4.4. Outputs

The outputs required from a benthic characterisation survey will vary according to the scale and nature of the proposed development. The rationale behind the survey should be clearly presented, as described in the Introductory Chapter GN030-intro (Section 2). As a minimum, for any project requiring EIA, or any project that might impact a protected site, we would expect mapping showing:

- The different species assemblages recorded (seabed habitat/community types) generally using the JNCC/EUNIS classification.
- Any areas of protected habitats or records of protected species (for example, Habitats Directive Annex I habitats and protected benthic epibiotic and infaunal species (such as those listed under Section 7 of the Environment (Wales) Act 2016 or on the OSPAR list of threatened and/or declining species and habitats)).
- The exact location and extent of the proposed development and the Zone of Influence, in relation to the seabed habitats and any protected habitats/species.

Where possible, it is useful if the habitat maps can also be provided as a GIS layer in a format compatible with ESRI ArcGIS, as this will enable us to easily display the data supplied against other data that we hold. The seabed habitats should be clearly described and additional information, such as results of univariate and multivariate analyses may also be presented. Where images have been collected, it is useful for habitat descriptions to be accompanied by representative images.

Commonly used non-geophysical survey methods for subtidal habitat characterisation survey and/or ground-truthing of geophysical survey data are summarised below:

Table 1. Commonly used non-geophysical survey methods for subtidal habitat characterisation survey and/or ground-truthing of geophysical survey data

	Habitat indicated by geophysical and/or existing data						
Survey / ground-truth methods commonly used	**Sediment**	**Rocky**	**Biogenic reef**	**Seagrass beds**	**Application**	**Considerations**	**Relevant chapters of the guidance for further information about the methods**
Grab samples • **Day grab recommended for use in soft sediment (such as mud and sand)** • **Hamon or Mini-Hamon grab recommended where significant fraction of coarser sediment (such as gravel) present**	Yes	No	No	No	Quantitative data on infauna and sediment particle size Stratified sampling can provide indication of habitat extent and distribution Samples may also be required for measuring contaminants in sediments	Grabs and box cores can be damaging to some habitats such as biogenic reefs or seagrass beds. Generally, these methods should not be used where such habitats are thought to be present.	Chapter GN030h (subtidal sediments)
Core samples **Vessel-deployed box corer or cores collected on diver survey**	Yes	No	No	No			

	Habitat indicated by geophysical and/or existing data						
<u>Underwater imagery</u> **Options include:** • **Drop down video** • **Towed video** • **Remote operated vehicle** • **Autonomous underwater vehicle** • **Digital Image Scanning Sonar**	Yes	Yes	Yes	Yes	Visual data on conspicuous epibiota and semi-quantitative estimates of abundance Visual data on sediment type Habitat/biotope extent if sampling along transects Identify transitions between habitats and habitat boundaries Plan-view photography can provide % cover data Can help identify small-scale habitats such as rock outcrops	Towed image systems can physically impact biogenic reef habitat. Consideration should be given to using methods that have less physical contact with the seabed than more conventional towed systems, for example a flying array	<u>Chapter GN030c</u> Horse mussel *Modiolus modiolus* reefs <u>Chapter GN030d</u> *Sabellaria* spp. reefs <u>Chapter GN030f</u> Seagrass beds <u>Chapter GN030h</u> (subtidal sediments)
<u>Diver survey</u> • ***In* situ counts of epibiota** • **Quantitative sampling using, for example, quadrats** • **Collection of underwater imagery (quantitative and semi-quantitative)** • **Collection of core samples**	Yes	Yes	Yes	Yes	Quantitative and semi-quantitative data on epibiota (*in situ* and imagery) Visual data on seabed type (and quantitative data from diver-deployed cores)	Generally used: • where other means (such as remote underwater video) are not effective because of ground conditions • if finer detail needs to be recorded during a survey that would be difficult to determine from underwater video footage	<u>Chapter GN030c</u> Horse mussel *Modiolus modiolus* reefs <u>Chapter GN030d</u> *Sabellaria* spp. reefs <u>Chapter GN030f</u> Seagrass beds

	Habitat indicated by geophysical and/or existing data						
• **Targeted collection of epibiota** **In shallow water seagrass beds, snorkelling can be used for some sampling approaches**						• to ground-truth underwater imagery Not effective for survey of large areas	Chapter GN030h (subtidal sediments)

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Published by:
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