ECA Regional Monitoring Blueprint

Specifications and Operating Procedures

Ecological Monitoring Surveys

Document Information

This document has been prepared by Emu Ltd and the ECA to ensure that a standardised set of procedures are applied during ecological survey work during the ECA regional monitoring programme.

This SOP is a final version that documents the procedures employed during the baseline surveys undertaken in August-September 2005. Further issues of this SOP may subsequently be circulated. This SOP has been circulated with Blueprint Version v011005.

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1. Introduction

This document has been produced in support of the ECA Regional Monitoring Blueprint (v0.3 041005). The purpose of the document is to provide the basic, minimum operating specifications for survey vessels, equipment and techniques that will be employed during baseline ecological monitoring surveys specified in the ECA Regional Monitoring programme.

Work to be undertaken under the specifications and operating procedures (SOPs) presented in this document is more fully described in the ECA Regional Monitoring Blueprint (v0.3 041005). The SOPs are presented in order to provide regulators with a basis for quality assurance and performance review, and prospective survey Contractors with a basis for contract tendering.

2. ECA Monitoring Blueprint Ecological Surveys

Due the constraints of time, and the timing of component regional monitoring surveys, the ECA intends to provide Specifications and Operating Procedures (SOPs) sequentially, prior to the surveys or activities to which they relate. On this basis, this document relates to the initial ecological, biological and habitat baseline studies that have been proposed in the ECA Regional Monitoring Blueprint (v0.2 180705).

This document provides SOPs relevant to methods of survey that will be used during the regional monitoring programme to provide the broadscale ecological baseline data. Specifically, the following survey methods are described:

- **Single Beam and Swath Bathymetry**
- **Sidescan Sonar**
- **Video/Camera**
- **Benthic Grab (Hamon grab)**
- **2m Beam Trawl**
- **4m Beam Trawl**
- **Scallop Dredge**

The document also provides information relevant to minimum standards for the following:

- **Vessels**
- **Positioning**
- **Survey equipment**
- **Data processing**
- **Charting**
- **Reporting**

Further SOPs to the ECA Regional Monitoring Blueprint will be provided prior to each subsequent Phase of the monitoring programme.

Further SOP documents will be produced that cover the remaining ECA regional monitoring studies (Seabed Sediments Plume, Tracer etc). These will be issued for review to regulators and relevant stakeholders prior to tendering for work to be undertaken.

3. Specifications and Operating Procedures

The following sections provide information related to the methods and operating procedures that will be employed during works undertaken by the ECA, or contracted parties, during Phase 1.

Contractors should be fully aware of implications of undertaking works within the English Channel VTS. Provision should made during all surveys for management of issues related to working in the English Channel.

3.1. General

3.1.1. Vessel Specification

Grab sampling, 2m trawl, sidescan (bathymetry) and video/camera surveys will be undertaken from dedicated survey vessels. 4m beam trawl and scallop dredge sampling may be undertaken from capable and certified fishing vessels, or capable survey vessels.

All dedicated survey vessels must be certificated to a relevant standard for survey operations in the region of the works. Where fishing vessels are employed to undertake trawl sampling, vessel specifications may vary from those specified in the following sections, however fishing vessels must comply with all relevant fishing industry safety standards. Any fishing vessels employed in works in the region shall be able to accommodate scientific personnel required during the 4m trawl and scallop dredge sampling work.

Contractors must provide evidence of vessel certifications to the ECA with tender documents. Where such certifications for a vessel are not available, a suitable vessel may be used in agreement with the client, Contractor and the MCA. Whilst more specific vessel equipment specifications are given in later sections the dedicated survey vessel must be checked before the survey to ensure it has a minimum of the following:

- **All relevant Health and Safety documentation**
- **Echosounder, radar**
- **Hydraulic winch with adequate length of cable in good condition**
- **Sufficient clearance for the grab at back/side of the boat**
- **Adequate deck space to work on**
- **Skipper with VHF licence and valid relevant qualifications**
- **Deck wash**
- **Water (drinking) supply**
- **Power supply – 12v**
- **Position fixing equipment**
- **Adequate provision for networked computer hardware use**
- **Adequate space for the number of people working**
- **Adequate space for storage of benthic samples**
- **Safety equipment - Liferaft, VHF Radio, Flares, CO_2 extinguishers etc.**
- **Toilet (HSE requirement)**

- **Sufficient cabin space**
- **Adequate provision of spares and redundant equipment to ensure that survey is not unnecessarily delayed due to equipment malfunction or loss.**

3.1.2. Vessel Requirement Details

The dedicated survey vessel shall have been purpose built or suitably converted to undertake survey operations in the designated geographic area (Figure 1).

The East Channel Association (ECA) reserves the right to carry out, either directly or through an appointed agent, a Health, Safety and Environmental (HSE) audit of the vessel in accordance with the ECA's procedures prior to acceptance for survey work.

The specifications below are provided as a guide. Preference will be given to vessels satisfying all, or the majority, of the listed points.

Surveys undertaken under the terms of these SOPs should be undertaken using the most appropriate vessel for the work. A dedicated survey vessel will be required for sidescan, video, grab and 2m beam trawl survey work. In the case of 4m trawl and scallop dredge surveys, it is likely that the most suitable methods would involve the use of a dedicated fishing vessel. It is acknowledged that such fishing vessels may not conform to the guideline specifications given below.

The dedicated survey vessel shall be capable of remaining safely at sea for a minimum period of 28 days when working in the designated survey area.

The vessel's dimensions, propulsion systems and navigational equipment should allow for the safe and capable acquisition of required data sets on a 24hr basis.

The vessel shall have a minimum transit speed of 8 knots and shall be capable of surveying for extended periods at less than 4 knots.

The vessel shall be proven to be acoustically quiet to enable good quality acoustic data to be acquired. The acoustic noise signature shall be acceptably outside the acoustic frequency range of the survey equipment to be deployed from the vessels.

A stabilised AC power supply shall be available for running survey equipment. This shall be separate from the vessel's services power supply.

Sufficient certified and suitably located handling machinery shall be provided for the safe and efficient deployment and recovery of survey equipment available on the vessel.

Vessel deck areas used for survey operations shall have good lighting and be free of trip hazards. All areas of the vessels used for the survey equipment deployment/recovery shall be either visible from the bridge, or good quality closed-circuit television pictures of such areas shall be provided on the bridge at all times of such operations.

The vessel shall be fully classed and equipped to meet International safety requirements. All safety equipment shall be fully certified. The languages of the majority of the vessel's crew shall be English. All safety notices and procedures shall be in English. Where members of the crew do not comprehend and/or speak English, arrangements shall be in place to ensure instructions, safety notices, procedures and feedback is communicated in an unambiguous manner, without compromising the health, safety and integrity of the crew, vessel and operational activities. Notices shall be displayed in appropriate locations throughout the vessels.

Personnel joining the vessel shall be fully briefed on the location and use of the safety equipment and a lifeboat and fire drill shall be undertaken on passage to site at the commencement of a survey cruise. Safety drills shall be conducted at not less than 7 day intervals thereafter. Safety drills shall be programmed to ensure practice in a variety of potential emergency response procedures.

The dedicated survey vessel shall be equipped with the following minimum communication equipment :

- **Email facilities with dedicated client address**
- **Multi-channel VHF R/T capable of working all frequencies and with a dual watch facility;**
- **Ship-shore R/T with a minimum range of 300 kilometres or capable of communicating with the Dover VTS management centre.**
- **Inmarsat satellite communications telephone, telex and facsimile;**
- **Good quality voice two-way communications system linking the vessel bridge and instrument room with all the main areas of survey operation; and**
- **Hand-held radios for operating in areas of the vessel not covered by the internal communication system.**

The vessel shall be fitted with the following navigation and steerage control aids:

- **Gyro compass (in addition to magnetic compass) with optional repeater to survey**
- **Positioning system;**
- **Marine radar;**
- **Satellite positioning receiver;**
- **Marine echo sounders (multi and single beam) with hull mounted transducers;**
- **Auto pilot; and- bridge control of engines and thrusters.**

The vessel shall have sufficient cabins to accommodate all survey personnel in addition to the vessel's crew. These shall preferably be single cabins but shall be no more than double berths. As a minimum the ECA Representative's cabins shall be single cabins and be fitted with adequate desk space and drawers.

Accommodation and victualling shall be of a high standard. Appropriate laundry facilities shall be provided. A communal rest-room shall preferably be provided with comfortable seating.

The dedicated survey vessel shall have the following minimum work areas which should be clean and tidy and have adequate space for the work to be carried out.

- **Positioning instrumentation work area.**
- **Geophysical instrumentation room.**
- **Data processing/interpretation rooms (which should contain adequate facilities for the safe storage of data).**

Each work area shall be fitted with adequate secure storage for consumable items, spares etc.

All cabins and internal work areas shall be adequately ventilated to ensure a comfortable and healthy work environment. If climatic conditions are expected to be humid and/or hot then the ventilation shall be supported by a suitable air conditioning system.

The dedicated survey vessel shall be fitted with a modern and robust A4 photocopier which shall be capable of providing good quality copies. Whilst it would be advantageous, this is not a requirement for any fishing vessels employed in trawl or dredge operations.

3.1.3. General Vessel Operational Considerations

Contractors and crew working on vessels undertaking work in the ECR should note the following general operational requirements:

Access to the vessel must be limited to the crew, survey staff and anyone sub-contracted to them.

If the vessel is hired with crew, the responsibility for their safety ultimately rests with the vessel operators. However, the survey team leader should satisfy him/herself that the safety standards are adequate. Risk Assessments should be available for view for all operations to be carried out during the survey.

All personnel should be familiar with the location of the safety equipment on the vessel eg life boat/raft and fire extinguishers. Briefings must be provided to the survey team and vessel crew regarding the safety management systems employed.

Weather forecasts should be available onboard. Forecasts should be obtained from the vessel watch officer by the survey team leader before embarkation and daily during the survey operations. Forecasts should be obtained from a reputable source (eg. Southampton Meteorological Office or metfax) with as much detail about wind and sea conditions as possible.

Life jackets must be provided on the vessel or may be taken on to the vessel by personnel provided they of required safety specifications. Life jackets must be worn at all times when working on deck.

Safety footwear must be worn when working on deck.

Safety headgear must be worn when working on deck.

Protective gloves (thick rubber) must be worn when handling grabs or cables.

Footwear must have appropriate soles with good grip.

Care must be taken when boarding the vessel. If there is a risk of entering the water whilst boarding the vessel, life jackets should be worn. At all times personnel should move around the vessel with caution.

Before handling and operating equipment make all crew should be familiar with the appropriate safety guidelines.

Any accidents or incidents must be reported to the person in charge and recorded in the appropriate accident book.

When sampling, any cuts or grazes on exposed parts of the body should be covered with waterproof plasters/dressings.

Long hair must be securely tied back when operating equipment.

Smoking is forbidden when collecting samples or when in any of the vessels designated working areas. Areas where it is safe to smoke will be agreed with the vessel captain and communicated to onboard personnel before embarkation.

Antiseptic wipes will be available and should be used for cleaning hands before eating and drinking.

The working deck area should be kept as clear as possible, especially areas where equipment is being deployed or retrieved.

A first-aid kit (complete with basic first-aid equipment including emergency eye-wash) must be taken on each survey.

3.1.4. Personnel

Offshore operations shall be conducted on a 24 hours basis and sufficient vessel and survey personnel shall be retained onboard to ensure maintenance of good performance levels and general survey efficiency over the projected period of the survey.

Contractors will agree the proposed crew lists with the ECA during the survey tender process.

The vessel captain and watch officers, and senior engineer should have adequate experience of site survey work.

Copies of individual Curriculum Vitae (Resumes) may be requested to confirm the level of experience and safety training. Training shall also include appropriate sea survival, firefighting and first aid or emergency medical skills, and an ability to respond to relevant potential emergency situations. All personnel sea survival training will be certified to a minimum of IMO STCW95 standard or equivalent.

All personnel sailing on the vessel are expected to be medically fit and the Contractors are required to ensure that regular medical examinations are undertaken to IMO STCW95 standard or equivalent.

All proposed personnel certifications should be available for review by the ECA.

The Party Chief/Survey Team Leader shall be the Contractor's nominated Offshore Survey Representative and shall liaise directly with the ECA Representative (onshore or offshore).

The vessel captain and survey team leader will communicate directly with each other on a daily basis regarding work plans, weather, fisheries/navigation liaison and traffic separation zone restrictions. Prior to signing off of daily reports the proposed 24 hr work plan will be agreed between the captain and survey team leader. Daily reports will be forwarded to relevant authorities as required.

1.1.5. Computer Systems

1.1.5.1. Online Systems

Acoustic Surveys

The online computer system shall be interfaced to all survey sensors and shall be configured such that a correct mathematical solution is observed in the following areas:

- **Co-ordinates of antennae, datum points and survey sensors. The computation shall encompass raw position line data, corrections, offsets, orientation and datum shifts;**
- **System comparisons between positioning systems;**
- **Raw survey data and time;**
- **Geodetic datums;**
- **Corrections, offsets and shifts applied;**
- **Preplots and indication of sail line and survey sensor track against those proposed;**
- **Range and bearing to target and offset from proposed sail line; and**
- **System accuracy indicators.**

Cycle time for computation shall not exceed 3 seconds. The computer shall include a real time clock.

Data shall be logged, in duplicate, in a format acceptable to the ECA (Section 2.1.1.) and in such a way that re-computation from raw data utilising alternative corrections is possible.

Benthic Surveys

Online computer systems shall provide fix positioning as specified in the methods below (Section 1.2), for all benthic grab, trawl, and video surveys.

3.1.5.2. Offline System

An offline computer system shall be supplied which shall include appropriate plotters and printers in order to provide provisional survey charts from observed data.

Data shall be capable of being passed from the online to the offline system where recomputation can take place as required and track plots and seabed information can be supplied in provisional form.

The offline system should be capable of carrying out re-computation of observed survey data as well as performing standard geodetic computations and conversions.

3.2. Positioning and Equipment Calibration

3.2.1. Positioning

1.2.1.1 General

Positioning shall be carried out in a controlled manner such that co-ordinates are derived with sufficient accuracy to meet the needs of the project.

Positioning systems shall be installed, calibrated and operated in accordance with manufacturers' instructions in order to supply sufficient accurate positioning information to control the survey.

Data from the positioning, orientation, measurement and computational systems shall be checked or self-checking in such a way that co-ordinates of the vessel datum points are provided correctly and are demonstrated to be correct.

All calibration corrections, adjustments, offsets and changes to positioning data shall be recorded and displayed during the execution of the survey. The application and nature of any data smoothing shall be indicated.

Annotation relating to any set of co-ordinates shall indicate the location being positioned, the system utilised for positioning and the nature of adjustments applied during computation.

Equipment, cables and antennae shall be installed in such a way as to minimise vessel communication or other systems interference and to ensure that data provided is of optimum quality.

3.2.1.2. Differential Global Positioning System (DGPS)

DGPS shall be used for positioning control. Its use should follow the Guidelines published by the UKOOA Surveying and Positioning Committee (1994), in particular the recommendations on quality monitoring and acceptance criteria.

In general:

- **Real time pseudorange correction updates shall be received at least every 5 seconds. Correction data must be received from at least two reference stations and multi-station position comparison must be available;**
- **A 10 degree minimum mask angle shall apply;**
- **Satellite coverage shall have at least 5 satellites available with acceptable geometrical constraints; and**
- **Height aiding control may only be utilised with prior ECA Representative approval of method and relative weighting. In general it should not be used.**

Prior to deployment, receiver tests and calibrations shall be carried out at a point with known co-ordinates, to verify the normal operation of the receiver. Data relating to these checks must be available on the vessel. Full back-up of all operational equipment will be required.

Where appropriate each reference station and monitor will be established with respect to existing local control and co-ordination and shall be subject to ECA approval.

Corrections shall be computed and broadcast at least every 5 seconds in RTCM 104 format via Inmarsat or a reliable radio (HF) link. Landlines to control hub/uplink station shall be duplicated and automated switching from one to the other shall be possible.

All equipment at reference stations shall be backed up 100% and automated switching between all parts of the installation shall be possible in case of equipment failure. GPS receivers shall be of the “all in view” type.

If a monitor station is used, corrections from each reference station shall be received and used to compute position. Real time processing shall be undertaken to prove system acceptability and QA statistics and displays shall be produced routinely and on demand, without interruption to the reception and processing of real time data. The monitor station shall be manned 24 hours per day and have communication with the vessel and reference station personnel. Ideally, the monitor station software shall be able to change configurations, reboot systems etc. at the reference stations.

Raw data shall be logged (if appropriate) continuously at all reference/monitor stations and on the vessel including, but not limited to, raw pseudo-ranges, time and derived corrections.

All equipment installed on the vessel shall be duplicated. The GPS antennae shall be mounted at the highest point on the vessel with care being taken to minimise interference from other antennae and multipath effects. Communication antennae, eg. Inmarsat domes, shall be located in positions affording clear visibility.

The DGPS system onboard the vessel shall be capable of passing computed positions and any other required data, eg. quality measures (F and W-test values), DOPs, to Contractor's positioning computing package in whatever format necessary at an update rate of 1 second. This infers the ability to compute position from the most optimal satellites available, within operational constraints, and the conversion of this position to local spheroid/datum.

The GPS equipment shall be situated in close proximity to Contractor's positioning computer package so as to facilitate easy and quick referencing from one system to another.

DGPS software on the vessel shall allow for full statistical areal analysis, together with the ability to review performance, configurations etc., without interfering with real time operations. Contractor's systems shall be capable of generating test statistics and quality measures as follows :

- **W-Test-using a 99% confidence level. Mean W-test for each observable shall average zero over each line with minimum and maximum values being -2.58 to +2.58 respectively. F-Test-mean of the unit variance computed by the F-test for each line shall be 1.**
- **Error Ellipses shall be drawn at a confidence level of 95%.**
- **External reliability - Marginally Detectable Errors (MDE's) shall be generated for each observation noting a 'significance level' of 1% and a 'Power of Test' of 80%.**

The following list shall be generated as appropriate:

- **Normalised residuals;**
- **Rejections highlighted by W-Test;**
- **Average unit variance;**
- **Rejections highlighted by F-Test;**
- **Positional standard deviations of latitude, longitude, height;**
- **Semi-major axis and direction of error ellipses; and**
- **MDE's.**

In addition, regular comparisons shall be made with results from other reference stations.

Only satellites for which reliable correction data are available shall be used.

Height aiding shall only be allowed after agreement with ECA. Values derived from published geoidal models and "project observations" can be used for height input.

Satellite availability, DOP prediction etc., software shall be available on the vessel and accessible without hindering real time operations. As a guide, reliance on DGPS shall be classified as marginal five minutes either side of poor coverage periods.

The Contractor's formal Report of Survey shall include the following information in relation to DGPS aspects of the Work:

- **Reference station descriptions**
- **Co-ordinates, height, general site details;**
- **Hardware/software review; and**
- **Transmission details.**
- **Inventory of all equipment used on the vessel including schematic of operation set up, serial numbers and cabling.**
- **Onboard antenna offset diagram.**
- **Details of satellite 'health' changes during work.**

Data logged shall include satellites used, ephemeris data, raw GPS positions, differential corrections determined at each reference station, final co-ordinates and precision/accuracy indicators verifying correctness of operation, reception and geometry (if appropriate). Formats to be agreed by ECA Representative.

3.2.1.3. Gyro Compass

A precision survey gyro-compass shall be interfaced to the positioning computer to provide vessel orientation for computation of offset positions of sensors from the DGPS antenna and for storage in the positioning data base.

Where a portable gyro is being used this should be secured in a permanent position with its axis parallel to that of the vessel for the duration of the survey.

Prior to departure from port the vessel orientation indicated on the gyro shall be compared with the vessel orientation determined by land survey methods based on triangulation control in the vicinity of the port. This data shall be available on the vessel.

Additional gyro checks shall be carried out prior to, during and on completion of the survey by sextant observations between the ship's head and a remote platform/rig with known coordinates. Where no offshore structures exist in the survey area, sun azimuths should be observed.

Accuracies of ±0.25 degrees are anticipated and acceptable.

3.2.2. Tracking System

An ultra short baseline (USBL) acoustic system may be used to determine the position of towed geophysical equipment and sensors used during the survey. If employed, the system shall have sufficient range for the expected survey area water depth and maximum sensor offset.

The system shall have been regularly calibrated by “boxing-in” a seabed transponder by circumnavigating it at a minimum separation of twice the water depth on fixed headings followed by observations at the four cardinal point headings. A full calibration need not be carried out prior to every survey, but data relating to the latest USBL calibration shall be available onboard.

Correct operation of the USBL system shall be verified by locating an identifiable seabed feature using side scan sonar and by recording sonar data in two reciprocal directions of survey. Adjusted co-ordinates of this feature shall agree to better than their required survey accuracy.

3.2.3. Tidal Correction

Tidal data for the survey region is to be transposed from a standard port in the vicinity (Shoreham, Newhaven, Dover), using co-tidal factors derived from the Admiralty Co-tidal Chart 5058.

When necessary, in support of geophysical surveying activities, a pressure monitoring tide gauge may be deployed at a control/reference location within the region for a period of not less than 30 days to provide real-time base line proving of co-tidal factors. Thereafter these factors shall be adopted and consistently applied to all surveys of the region.

3.3. Survey Methods

All acoustic survey methods shall employ real time display of data in order that QC of data can be undertaken in the field.

Review and assessment of data in real time will be undertaken as follows:

- **Single-beam echo sounder data will be plotted during the survey using a thermal plotter. Data will also be recorded digitally.**
- **Multi-beam data will be displayed in real time on board the vessel on swath system screens.**
- **Side-scan sonar data will be displayed in real time during the survey using paper plotters and will also be recorded digitally.**

3.3.1. Single-beam Echo Sounders

A precision dual frequency survey echo sounder shall be provided together with hullmounted transducers and shall be interfaced to a heave compensation unit located close to the position of the echo sounder transducers.

The operating frequencies of the echo sounder shall be 33 kHz and 210 kHz (or similar).

Water depths shall be recorded in digital form and on a paper recorder. Digital soundings shall be logged at least every 0.5 seconds.

Paper speed and range scales shall be selected for optimum resolution across the survey area.

The depth of the echo sounder transducers shall be verified (preferably in calm seas) prior to and on completion of the survey or at 7 day intervals (whichever is the shorter period). If requested, this shall be checked by the 'Bar Check' or an equivalent method. The maximum allowable error shall be 0.1 metres.

The speed of sound in water shall be measured in the survey area at the start and end of each survey period or at intervals not exceeding 4 days (whichever is the shorter period). The measurement shall be made using a calibrated Velocimeter or calculated using Temperature and Salinity measurements. Measurements shall be taken at a maximum of 10 metre intervals from the sea surface to the seabed. A second set of readings shall be taken from the seabed to the sea surface and the speed of sound computed from an average of all the derived values.

The performance of the heave compensation device shall be checked at regular intervals, by switching it off, or removing from the system, to ensure no fixed errors are being introduced to the depth measurement.

Temperature/Salinity measurement instrumentation and/or velocimeters shall be professionally calibrated at not more than 6 monthly intervals; and calibration certificates shall be available for inspection on the survey vessel.

3.3.2. Multi-beam Echo Sounders

3.3.2.1. Swathe Systems

A swathe bathymetry system (Simrad, Reson, or similar) shall be provided that is suitable for the water depths and conditions likely to be encountered.

The multibeam sonar transducer array shall be hull mounted. Over-the-side transducers mounted on a rigid frame attached to the vessel hull are not acceptable.

The system shall accommodate input from a high precision, vertically referenced, 3-axis motion reference unit (MRU).

The system shall include a high-performance, digital data acquisition system, plus quality control features including a high-resolution colour plotter suitable for shipboard use.

The following minimum multibeam sonar system capabilities are required:

- **Operating Speed: Up to 10 knots**
- **Nominal Operating Frequencies :**
- **Water depth 0 - 100 meters >90 kHz**
- **Beamwidth (Transmit x Receive) :**
- **Water depth 0 - 50 meters 2 degrees x 2 degrees or less**
- **Beam Spacing Configuration: Equi-angle or equidistant (system dependent)**
- **Number of beams per ping: minimum of 120**
- **Coverage Sector: 90 to 150 degrees**
- **Depth Resolution: 0.2% of water depth**

The multibeam sonar system shall also be capable of:

- **Data adjustments for refraction ray bending**
- **Recording and Processing backscatter amplitude data to produce seafloor imagery (pseudo-side scan imagery).**

The MRU interfaced to the multibeam system shall satisfy the following motion detection and correction requirements:

- **Heave correction accuracy 5% of measured heave**
- **Roll correction accuracy 0.05 degrees**
- **Pitch correction accuracy 0.05 degrees**

The MRU stabilisation rates shall be such that all corrections are within the tolerances specified below:

- **Within 3 minutes of a 180° change in vessel/vehicle heading**
- **Within 20 seconds of a 30° change in vessel/vehicle heading**

As a minimum, the multibeam bathymetry system shall be configured to interface with:

- **A Differential GPS surface positioning system or a USBL underwater positioning system, as appropriate.**
- **A gyrocompass or an inertial navigation aid heading indicator device, as appropriate.**
- **A high precision, calibrated depth sensor (towed systems only).**

3.3.2.2. Swathe Calibration

Prior to acquiring data, system calibrations shall be required. These shall be undertaken in accordance with the manufacturer's specifications and shall include :

- **Calibration for Speed of Sound**
- **Calibration for Transducer Index Error**
- **The transducer depth shall be verified by comparison to echo sounder data. This will be carried out immediately before and after the survey. The maximum allowable index error shall be 0.1 metre.**
- **Calibration of Roll Offset**
- **Generally, the roll offset calibrations shall be undertaken over a flat seabed. Two perpendicular survey lines shall be acquired. The centre beam from one survey line shall be in exactly the same position as a single sweep of data from the line in the perpendicular direction. These two profiles shall be compared and a correction factor calculated.**
- **Calibration of Pitch Offset**
- **Pitch offset delay calibrations shall be undertaken over a steep slope (if possible). A single survey line shall be acquired in the along-slope direction in two opposing directions. A difference map shall be produced from the two passes and a correction factor shall be calculated. A third pass shall be conducted after the correction has been applied to the system to confirm the results.**
- **Calibration of Gyro Offset and Alignment**
- **Gyro offset calibrations shall be undertaken over an isolated feature on a flat seabed. The feature shall be situated midway between two parallel survey lines acquired in opposite directions. A map shall be produced showing the object on both lines. Any spatial errors shall be corrected by calculating a gyro offset.**
- **Calibration against a Conventional Echo Sounder**
- **A standard dual frequency echo sounder and the swathe system shall acquire data simultaneously along a line. This can be**

conducted as part of the calibration for roll offset. The depth shall agree within the tolerances of the two systems. Where possible this shall be conducted in both deep and shallow water to ensure that any differences noted are not fixed or depth dependent

3.3.2.3. System Operation

The compliance of the system with the above calibration procedure and the manufacturer's specifications shall be checked before survey start-up. Additional or repeat calibrations to confirm the integrity of the system may be requested at any time by the ECA.

Unless otherwise directed by the ECA, the following minimum schedule of calibrations shall be adopted during multibeam bathymetry survey operations:

- **Seawater velocity observations: every 12 hours**
- **Transducer depth observations: every 12 hours**

Survey technicians shall ensure that both the required coverage and quality of calibration measurements are recorded.

The system shall be operated in the mode appropriate for the depth of water at the survey site and to satisfy the data density and coverage requirements specified by ECA.

Course alterations while on line and acquiring data shall be kept to a minimum and, if necessary, must be carried out so as not to affect the accuracy of the MRU.

The density of depth sounding data points recorded shall satisfy the horizontal resolution, quality assurance, binning/gridding, and editing requirements specified by the ECA.

The speed of the vessel during data acquisition shall be governed by the required data density, water depth, system-specific parameters (e.g. maximum ping rate, etc.), and data signal to noise ratio. Data shall not be acquired at vessel speeds likely to compromise the coverage requirements.

Data acquisition shall not resume after vessel turns until the output from the MRU has stabilised.

Unless otherwise specified by the ECA, the survey line spacing shall ensure that sufficient redundant data is acquired to satisfy the requirements of the proposed data processing regime and satisfy coverage requirements. Overlaps of between 25% and 100% may be necessary depending upon sea state, MRU performance, and water turbidity. Manufacturer's guidance shall be followed in assessing the required overlap for the particular survey situation.

Unless otherwise sanctioned by the ECA, no data shall be acquired in weather and sea conditions that may compromise the quality or integrity of the data set. It is Contractor's responsibility to review and assess the quality of the data acquired in realtime.

A hydrographic echo sounder shall be operated at all times during the multibeam bathymetry survey. Direct comparisons shall be made between equivalent seabed profiles. The differences between depths recorded by the multibeam bathymetry system and the hydrographic echo sounder shall not exceed the combined accuracy tolerances specified for the two systems.

Raw data shall be recorded onto a suitable digital storage medium, which shall be write protected once recording has finished. The recorded raw data shall be duplicated and the duplicate copy retained onboard the vessel or elsewhere while the original is in transit to a shore-based processing centre.

3.3.2.4. Swathe Bathymetry Processing

The Contractor shall undertake the following processing and testing prior to final selection of processing parameters and production of charts:

Soundings shall be reduced to Lowest Astronomical Tide (LAT) at the survey location. Tidal heights shall be computed from either tidal predictions or observed tide elevations at tide gauges established by the Contractor at suitable locations within the survey area and approved by the ECA.

The quality of the raw data shall be assessed using the following colour QC plots

- **Raw soundings (based on sounding at centre of each bin, size to be determined dependant upon water depth)**
- **Number of soundings in each 5 x 5 m bin**
- **SD of the values within each 5 x 5 m bin**

In addition the following shall be produced :

- **A series of profiles across several raw swathes of soundings along track profile based on the centre beam, with the standard echo sounder data plotted on the profile at the same scale**
- **Tidal correction data (to LAT), depth and system corrections (gyro, time errors, pitch and roll corrections) and squat correction shall be applied and the same plots as above shall be produced.**
- **A first pass spiking editor shall be applied. The parameter values shall ensure that no valid data is removed. The system shall be capable of flagging and editing out data without totally removing it from the raw data set. The same sequence of QC plots as above shall be produced.**

Filtering shall consist of the following:

- **Based on evaluation of the data, several outer beams may be edited out if data quality data is poor. The same sequence of QC plots as above shall be produced.**
- **The use of filtering based on statistical analysis of binned data shall be undertaken. The size of the bins shall be the same size as the final gridding bins. A series of test panels shall be produced with 1 x SD, 2 x SD and variable SD (where SD value is a function of the slope of the seabed) rejection criteria. The same sequence of QC plots as above shall be produced.**
- **The size of the bin shall be determined by the scale of the final charts, the seabed topography and the contour interval.**
- **A series of test panels shall be produced where each of the processing parameters are changed from the default values. Test panels shall be produced using the default smoothing factor, as well as using say +/- 10%, +/- 20% and +/- 30% alterations to the defaults smoothing factor.**

As a minimum contour smoothing, search radius, sector search radius and contour suppression shall be tested.

At the scale of the chart, at least 1 sounding per 25 mm2 should be posted on to the final chart (position of the sounding shall be the decimal point).

3.3.3. Sidescan Sonar

A digital dual channel side scan sonar system shall be supplied with the following general specifications:

- **Dual operating frequency approximately 100/500 kHz; but generally utilising The highest frequency compatible with achieving full coverage**
- **Horizontal beamwidth = 1 degree;**
- **Vertical beamwidth < 45 degrees (preferably variable and variable beam depression angle);**
- **Dual channel paper recorder (preferably thermal head recorder with high dynamic range);**
- **Dual channel digital recording, and**
- **Armoured cable on powered winch with slip ring assembly.**

The side scan sonar transducer settings (beamwidth and depression) shall be optimum for the operating water depth and range settings being used and shall be verified prior to surveying.

The side scan sonar sensor design towing characteristics, cable and vessel tow point shall be selected to ensure the towfish is adequately decoupled from any vessel pitching and rolling motion. The available cable length will normally be expected to exceed three times the maximum expected water depth in the survey area.

The side scan sonar winch shall have a remotely controlled variable speed with sufficient speed range for rapid deployment/recovery in areas of rapidly changing depth, and a sufficiently slow deployment rate such that the stability of the towfish is not significantly compromised. The winch shall be capable of remote operation, preferably from the geophysical survey instrument room.

Layback of the side scan sonar towfish may be measured by USBL acoustics, calibrated meter on deployment pulley or by physical measurement. Alterations to the tow cable length during surveying shall be recorded. If USBL techniques are not employed Contractors should specify their methods for measuring layback.

With due regard for any seabed hazards likely to be encountered on the seabed, the sidescan sonar towfish should be towed at a height above the seabed that provides optimal data coverage at the operating frequencies employed. Typical height of towfish above the seabed should be between 10-15% of the range of the sidescan and in all cases not less than 5m. The highest frequency utilised during ECA surveys will be 500kHz typical the maximum effective range will be 100m with the towfish towed at a height of 10-15m above the seabed. Although it is unlikely to be a significant problem in the ECR, temperature and salinity of seawater may reduce the effective range of the equipment final decisions regarding the optimal tow height and line spacing should be confirmed following determination of temperature and salinity profiles at the survey site.

The survey speed at which sidescan sonar surveys are undertaken shall normally be maintained at 4.0 knots (± 10%).

Side scan sonar slant ranges shall normally be sufficient to enable insonification of adjacent survey lines. Optimum ranges for the following line spacings are:

Line Spacing (if available)	Optimum Slant Range
25 m	50 m
50 m	75 m
100 m	125 m
125 m	150 m
150 m	200 m
200 m	250 m

Where unusual or changeable seabed character or specific features of interest are encountered, the range of the sidescan sonar may be adjusted to ensure that the resolution of such features is optimised. Such changes to the sidescan sonar range shall only be employed following agreement with the ECA representative and shall not compromise the overall aim of providing 100% coverage of the survey areas.

The sidescan sonar system should be set up to achieve optimum data quality and coverage at the beginning of the survey and settings that affect the nature of the raw data collected should remain constant throughout the survey. Bearing this in mind, and considering the possibility that specific features may require more thorough investigation, it is recommended that any re-survey of distinct seabed features at lesser sidescan ranges should be undertaken, when required, independently of the overall full coverage survey, with the data merged post-survey.

During mobilisation the side scan sonar system shall be tested by:

- **A 'rub' test of both transducers; and**
- **Wet-test under tow for 15 minutes at survey speed and using all ranges likely to be required during survey.**

The side scan sonar system shall be manually tuned (where appropriate) and any changes to recorder settings made during the survey shall be recorded.

Sufficient spares (including a spare towfish) shall be carried onboard the vessel to adequately maintain the sidescan sonar system and its peripheral equipment.carried out.

3.3.4. Video and Camera Survey

3.3.4.1. Camera Specifications

Stills camera systems should preferably record on a digital medium of minimum 4 Megapixel resolution or more to allow for review of the data upon recovery. The camera should be mounted onto the grab sampler to allow a view of the seabed prior to sampling.

The configuration of the stills camera system should allow for variations in view, strobe orientation and focal length in order to maximise data quality with respect to the prevailing conditions.

For the most part, the camera should provide an oblique stills photograph of the seabed covering a surface area of approximately 1 square metre. However, a capacity for a plan view (i.e. vertical) and a closer focal length of <50cm is also required in the event of poor water clarity.

A trigger delay of no more than 2 sec shall occur between trigger and photograph timing. The camera system is to be fitted with a strobe supplied in a separate housing to allow an offset of up to 90° from the camera's view.

All photographic operations are to be annotated into a field log which will be supplied at the end of the field operations. Information included shall be as follows:

- **Client and project details**
- **Survey date**
- **Site name and replicate number**
- **Easting and Northing**
- **Water depth**
- **Interpretation of pertinent features such sediment type, bedforms, local topographic features, significant epifauna and/or mega-fauna and habitat related features**

Photographic data from all sites should be provided as hardcopy plates and digital image files. Locations of photographic sample sites shall also be presented within the context of results from acoustic survey interpretations in order to provide ground-truthing for these surveys.

A chart of sample locations relative to seabed features will be supplied.

3.3.4.2. Video Specification

Video operations will be of three types:

1. **The first will be simultaneous to that of the stills camera deployment (attached to the grab) and will have a similar aspect and deployment configuration. The intention with this deployment is that images are collected just prior to taking the sample with the grab, to provide background habitat data and to prevent damage to sensitive habitats occurring. As such the video system will be deployed in the immediate vicinity of the grab sampler (<10m distance).**
2. **The second deployment is to provide standalone data at sites where grab sampling is not currently possible**
3. **The third is to confirm description of acoustically acquired habitat and biotope information. For 2 and 3, the video system will be installed within a drop down video frame which will provide a vertical view of the seabed with a focal length of approximately 50cm when static.**

The video will be supplied with its own source of illumination which will be no less than 150 Watts. Lights will be placed in such a way that no excessive bright or dark spots exist.

The video shall be digitally recorded onboard the vessel, with a means to review, replay, capture and extract data digitally immediately after acquisition. Should data be recorded direct to flash memory of DVD disk, then a secondary means of recording is also required (i.e. VHS or DV tape).

All recorded data shall be provided on multi-region DVD media on completion of the field operations.

3.3.4.3. Visual Monitoring Operations

Type 1 Operations

Visual images will be recorded during benthic grab operations and during the dedicated video transect survey.

Video systems shall be capable of real time surface monitoring and, if a stills camera is not employed, the video system shall be capable of producing still images of adequate quality.

Where deployed in conjunction with stills photography, the video will be used for targeting and stills trigger controls will be either by contact with the seabed or by electronic button.

Type 2 Operations

At the standalone video sites where the drop down system is employed a series of drops will be required at each sampling location. These will comprise of 5 separate static replicates, with drift coverage at intervening areas over a total length of approximately 100m.

Type 3 Operations

It is anticipated that the acoustic survey will identify habitat change over transects of seabed in the order of 1km long. Along the 1km long transect 5 sampling locations will be identified in relation to evident habitat types. At each sampling location 5 separate static replicates will be recorded, with drift coverage at intervening areas over a total length of approximately 50m.

All video footage will be annotated with the following:

- **Site Position**
- **Date, Time**
- **Water Depth**
- **Project Title, Client details, Site No. etc.**

3.3.5. Ecological Sampling

3.3.5.1. Site Location

Site location will be undertaken on the following basis:

- **Responsibility for positioning of the vessel rests with the vessel skipper or watch officer. The survey manager will provide a list of survey positions to the skipper or watch officer prior to commencement of grab operations. Prior to deployment of the grab sampling equipment, station positions are to be confirmed between the skipper or watch officer and the survey manager.**
- **Site position should be entered into the survey DGPS receiver as a way-point and the vessel positioned as close to this position as possible. Positioning should be finalised on the DGPS by the survey leader (or surveyor). The actual sampling position (ie the position when the grab hits the seabed) should be noted in the survey log. This applies to each replicate at each site where appropriate.**
- **If the positioning is to be carried out using distance and bearing from a known point rather than selection of a definite easting and northing prior to the survey, the survey leader (or navigator) must oversee the final positioning and take a position fix when the correct distance and bearing have been achieved.**
- **When such a position fix has been made, the position may be entered into the DGPS as a way point and positioning back on this site accomplished as described above.**
- **Additional information to be recorded should include: Weather and Sea condition; date; time (start and finish); scientist; depth recorded**

in metres taking into account the position of the transducer i.e may already be in 1m depth so add 1m to recorded depth to ascertain actual depth, sample volume; description of sediment type; observations on sediment structure; comments on artefacts present; initial faunal observations (see example Table 1).

- At start of logbook it should be noted as to what datum is being used, and what time and date format are being used.

3.3.5.2. Positioning

Position fixing will be undertaken using the survey vessels principal DGPS positioning system.

DGPS positioning should provide accuracy of ±5 metres.

The navigation system should be checked before the start of the survey to ensure that it is operating correctly. This should be done by installing the antenna at a suitable location at which the position is known to the same or higher accuracy than the DGPS system being used. Comparable methods are acceptable. The tolerance between the given position and the known position should be within the standard accuracy of the system as quoted by the manufacturer. If this is not achieved the set-up and functioning of the DGPS system must be checked and corrected so that the required accuracy is achieved. The navigation check details should be recorded for inclusion in the survey report.

Where possible, an on-, or near-site check of the DGPS system should also be conducted before commencement of the survey, and again each morning before departure if the survey runs over several days. Checks should be carried out in the datum in which the survey is to be conducted and is designed to ensure that the transformation parameters have been applied correctly and that no other changes in set-up have occurred. Due to the difficulty of obtaining a highly accurate position for a suitable site location from a digital chart/map, and due to the difficulty in positioning the survey vessel at an exact location, a tolerance of 30 m is deemed acceptable for these navigation checks. The navigation check details should be recorded in the field logbook.

3.3.5.3 Ecological Sampling Equipment

Generic operating procedures for undertaking benthic sampling are described below. Hamon Grab and 2m beam trawl information is based on widely accepted methods and procedures, including those employed by CEFAS (2001).

The exact nature of the 4m beam trawl will be compatable with gear used by CEFAS annual surveys of the Channel and will be based on the most commonly used commercial gear used in the region. For the Scallop dredge, the proposed sampling equipment is based on recommendations made by CEFAS involving use of gear based on the ‘Newhaven Dredge’.

Grab and 2m beam trawl operations will be carried out from a survey vessel.

4m trawl and scallop dredge surveys are likely to be undertaken using commercial fishing gear operated by fishing vessels capable of carrying out such operations. Scientific personnel will work aboard the chosen vessels to process faunal samples.

3.3.5.4. Hamon Grab and Sampling Equipment Specification

All faunal grab samples will be collected using a 0.1m2 surface area mini-Hamon grab. The grab shall be weighted with 100kg of lead to enable efficient penetration of the gravels in the EEC. In addition, and prior to collection of a seabed sample, a digital image will be recorded of the seabed at each grab location. Grab equipment employed under the terms of this monitoring programme will be capable of combining the grab and visual imaging operations.

Deck equipment shall comprise of:

- **A grab stand to support the grab before and after sampling. The stand shall be installed in such a way that a sample reception box may be fitted beneath the grab. The grab stand should be securely fixed to the deck.**
- **Sample reception box. This should be watertight and of sufficient volume approximately 50litres, to enable the full sample to be deposited. 2 litre graduation marks should be made within the box, up to a maximum of 24 litres.**
- **Sorting table with a controllable exit channel, into which the whole sample can be placed. Once the sample has been placed on the table it can be washed in small quantities into the sieve.**
- **Sieve. This should be of 1mm mesh and minimum 30cm diameter.**
- **Washing tank. The washing tank should be sufficient to allow the sieve and sample to be puddled efficiently.**
- **Plastic funnel and stand. A wide mouthed funnel designed to fit into the sample containers, without loss of sample, should be employed.**
- **A plastic scoop which enables a volume of 300 cm3 to be collected shall be used to sub-sample for particle size analysis.**
- **Pre-printed log book so that a routine list of observations are made (see example page Table 1)**
- **Laboratory wash bottles, clip lid sealable sample buckets up to 10L in volume, plastic bags for storage of PSA samples, deck hose, water proof pens and labels, chemical aspirator for 10% formalin storage. Contractors should be aware of restrictions with respect to the use of chemicals, particularly with respect to Formalin.**

Table 1 Example benthic field log.

Site No.:		Position:	
Time Arrive Site:			
Time Leave Site:		Depth (BSL):	

Grab No.		Time:	
Position:			
Sample Size:			
Sediment Composition:			
Sediment features: (circle)	Burrows Tubes Casts Smell:_____ Other:_____		
Sediment Anoxia: (circle)	None Streaks Patches Layer Depth of layer from surface:_____		
Anthropogenic features:	Sewage derived material:_____Other:_____		
Conspicuous fauna / flora:			
Sample collected: (circle)	FAUNA A B C D E	PSA A B C D E	
	Contaminants	Bacti	Other:_____
Photograph Taken:	YES NO		

3.3.5.5. Hamon Grab Operation

Grab operations should be undertaken using safe working practices. Contractors should follow suitable safety management procedures during preparation, deployment and retrieval. Full risk assessments should be available.

Contractors will ensure that all personnel engaged in handling of benthic sampling equipment employ the requisite personal protective equipment. Thick gloves, protective footwear and hard hats should always be worn when grab is in use.

General handling

Grab must only be handled using a suitably rated winch, crane or fork-lift vehicle.

Any securing or handling points for the grab are to be welded to the deck of the survey vessel or frame of the grab.

Loading

A minimum of three people must be employed in the operation of the grab, in addition to a winch operator.

All commonly accepted safety mechanisms shall be present and functioning on the grab used. Safety mechanisms shall be employed as required during winching operatons.

Deployment

When the boat is stationary and the skipper has agreed with the back-deck team leader that conditions are suitable, the grab may be deployed. Deployment is typically at a rate of approximately 1 ms-1. As the grab approaches the seabed the wire should be released more slowly to avoid the creation of a ‘bow wave’ which could wash away surface material. At this time the video system should be recording, with the option for a stills image to be collected immediately prior to the Hamon grab touching the seabed. Once the Hamon grab has reached the seabed, slackening of the winch wire provides a signal to stop the winch. The grab should then be raised, initially very slowly to maximise sampling efficiency.

When the grab reaches the surface it should be stabilized. If the orientation of the grab frame is incorrect, one person should hold the frame and turn the grab until the chain loops are accessible. The other two staff can then attach the hauling lines to the chain loops on the frame. The hauling lines are then manually pulled taut and the winching on to the boat resumed, maintaining the tension on the hauling lines until the grab is safely lowered on to the table. The hauling lines can then be safely removed.

Enough winch cable should be released to enable the lifting arm (and grab contents) to be released. In rough seas, the vessel should be orientated 'head to wind' thus minimising roll and reducing the risk of loss of control of the grab during deployment and recovery.

Samples should be released into the sample reception container and the total sample measured. In some cases samples may be rejected for a variety of reasons, as follows:

1. **If samples are less than 5l in volume (unless after 3 repeated attempts a larger sample cannot be collected). Full notes must be made.**
2. **If sediment has been obviously disturbed due to wash out due to the failure of the grab to engage with the stop plate.**

Further information regarding the handling of the sample is provided below in Section 1.3.6.

3.3.5.6. 2m Beam Trawl Specification

A 2m metre beam trawl will be employed consisting of a metal beam, a chain mat designed to prevent the collection of larger boulders, and chafers to limit net damage (see Jennings et al., 1999). The specifications of the gear are as follows:

Beam width	2m
Outer Net Mesh Size	8mm
Inner Sample (Cod end) Net Mesh Size	5mm (knotless)

3.3.5.7 2m Beam Trawl Operation

General Handling

Contractors will ensure that all personnel engaged in handling of the trawl sampling equipment employ the requisite personal protective equipment. Thick gloves, protective footwear and hard hats should always be worn when trawl is in use. Two people are required to keep equipment under control, especially to prevent swinging once the gear is clear of the deck.

Preparation

The protective chain mailing and the outer and inner bags should be checked thoroughly before the survey, for general wear and tear. Particular attention should be paid to the inner 5mm nylon mesh bag that will retain the faunal samples on the beam trawl frames. In addition, the connections between nets, bags etc. and the trawl frame should be checked. This procedure should be repeated briefly after each deployment to check for damage, particularly when working over rough ground.

Deployment

When using the beam trawl, the gear should be lifted from the deck using the winch with a person either side to keep it under control. The trawl should be held at the back of the boat and a final check on bags and nets made. The dredge/trawl should then be released, and deployed by the winch man. The length of warp is critical for the correct operation of all types of towed sampling equipment. In shallow water (<30 metres), the warp:water depth ratio should be in the region of 2 – 3:1. In water deeper than 30 metres the warp:water depth ratio should be at least 3:1

Once deployed, tension on the winch cable should indicate whether or not the trawl is on the bottom. A DGPS position should be obtained at the time contact is confirmed. The length of tow for the beam trawl will vary according to the ground type and epifaunal density, but as a general guide a target distance of 500m should be aimed for, although a tolerance of plus or minus 300m is acceptable. A position should be noted at the end of each tow. The towing speed for beam trawl should be around 1.5 knots over the ground.

Retrieval

If the trawl is swinging violently upon retrieval, drop it back into the water until the boat is more stable. Do not attempt to land it.

Hold the trawl by the frame and pull it into the boat where it may be lowered onto the deck. Inspect for damage and evidence of effective sampling. If significant dmage has occurred or the trawl has clearly not been effectively sampling the location should be re-run.

The fauna recovered in the dredge may then be assessed. When employing the beam trawl, sub-sampling of the retained sediment and fauna will be carried out. Section 1.3.6 provides the on-board sample processing methods although the following initial points should be made:

- **Due to the rarity of some species a full assessment of the occurrence and abundance of all species must first be undertaken. Sub-sampling may then take place to assess the more numerous taxa.**
- **The counts of the more numerous taxa from the sub-sample must be based on counting taxa from a known volume of sample, which is used to estimate numbers of this taxon in the whole catch volume.**

3.3.5.8. 4m Beam Trawl Specification

A 4m beam trawl rigged in the same way should be used for all sampling. The gear should be of a specification equivalent to that used for the annual CEFAS beam trawl survey in the eastern English Channel.

Permission to use a fine mesh liner, and to catch and retain undersize fish, should be requested from DEFRA and a letter of dispensation taken on board during all field sampling.

3.3.5.9. 4m Beam Trawl Operation

Vessel Requirements

Vessels operating the survey gear will be purpose built, or suitably adapted, to such use. Crew employed will be competent in both the safe operation of the survey gear and the processing of the faunal samples.

Trawling

All tows should be of 15 minutes duration (on bottom time), this time being from the time that the warp has ceased paying out to the time that hauling begins. Given that certain events may hamper fishing operations, tows of 10-20 minutes bottom time can be considered valid, tows of shorter or longer bottom time should be repeated where possible.

The amount of warp that is paid out should be 3x the water depth.

Tow speed should be 4 knots.

Detailed records should be kept of fishing operations, including shoot and haul time, position and depth. Information on sea and weather conditions (e.g. swell height, wind speed) should also be made available. Surface water temperature should be recorded, and bottom water temperature recorded if possible.

All fishing should be conducted during daylight hours.

When the net is retrieved, it should be inspected to ensure that there are no signs of gear damage. If there is significant gear damage that could have affected the catch composition, then that stations should be declared invalid, the gear repaired and the station repeated.

3.3.5.10. Scallop Dredge Specification

Each dredge shall consist of a ruggedly constructed triangular steel frame and tooth bearing bar or sword, behind which a mat of linked steel rings is secured. 4 dredges will be shackled to a hollow steel tow bar and fitted with chain bridles, one for each dredge.

The dredge used for surveys in the UK is the “Newhaven”. This has a spring-loaded toothbar that “gives” on contact with boulders, or other obstructions and allows the dredge to pass over. The belly of the dredge bag is constructed of steel rings while the back is of netting.

The scallop dredge will be designed to collect both adult and small scallops, queens and other benthic organisms, hence the employment of 55mm rings will be required. The tooth bar should have twelve teeth of 125mm length. A net back of 65mm stretched diamond mesh is suitable.

1.3.5.11. Scallop Dredge Operation

Vessel Requirements

Vessels operating the survey gear will be purpose built, or suitably adapted, to such use. Crew employed will be competent in both the safe operation of the survey gear and the processing of the faunal samples.

Dredges as described above should be fished in gangs on towing bars. A minimum of one gang of four dredges and ideally two gangs of four should be deployed at each station. Vessels will tow two bars, one on each quarter.

It may be necessary to obtain permission from Defra for the use of these dredges.

General Handling

Thick gloves, protective footwear and hard hats should always be worn when trawl is in use. Two people are required to keep equipment under control, especially to prevent swinging once the gear is clear of the deck.

Preparation

The protective chain mailing and the outer and inner bags should be checked thoroughly before the survey, for general wear and tear. Particular attention should be paid to the inner steel ring mat that will retain the faunal samples. In addition, the connections between ring mat, sword, etc and the dredge and trawl frames should be checked. This procedure should be repeated briefly after each deployment to check for damage, particularly when working over rough ground.

Deployment

When using the dredge, the gear should be manoeuvred as per the accepted safe working practices of the vessel employed to undertake the survey. The dredge should be held prior to final deployment and a final check on ring mats and frames made.

The dredge should then be released, and deployed by the winch man. Warp length/water depth ratio is generally around 3:1, but in bad weather or strong tides more wire may be paid out to keep the gear on the bottom. Normal towing speed is around 1.5-2 knots, with an effective maximum of 3 knots, as the gear may not perform as efficiently at higher speeds.

All tows should be of 15 minutes duration (bottom time), this time being from the time that the warp has ceased paying out to the time that hauling begins. Given that certain events may hamper fishing operations, tows of 10-20 minutes bottom time can be considered valid, tows of shorter or longer bottom time may not be comparable and should be repeated where possible.

Positioning and Log

Positioning of the dredge will commence at the point the dredge is confirmed to be upon the seabed. Fixes are to be recorded every 2 seconds during the dredge. End of line coordinates will be recorded at the point the trawl is confirmed to have left the seabed.

Detailed records should be kept of fishing operations, including shoot and haul time, position and depth. Information on sea and weather conditions (e.g. swell height, wind speed) should also be made available. Surface water temperature should be recorded, and bottom water temperature recorded if possible.

Retrieval

Retrieval of the dredge should be carried out by the fishing vessel crew as per the safe working practices of the vessel. Once aboard samples should be released from the dredge gear onto a safe area of the vessel for analysis.

3.3.6. Sampling Handling

3.3.6.1. Faunal Sample Handling

Processing of samples shall be undertaken as described below:

Grab

The sample should be decanted into the sample reception container. The volume should be measured. Full records of the sample should be made, and an accompanying photograph with an “in view” sample number recorded.

A sub-sample for PSA should be collected at this time. Optimum volume should be 300g but quantities up to 500g should be collected if sediments are particularly coarse. The volume removed should be recorded. Samples will be retained in strong plastic bags with full sample details on the outside of the bags and on internal labels.

The remaining sample should be decanted onto the sorting table. The sample should be washed gently with water and small quantities released through the drain channel into the 1mm mesh sieve. The sieve may then be puddled to remove any residual sediment. Large stones with no evident fauna may be removed to prevent damage to samples.

The sieved material and any retained stones should be transferred to sample pots, using a large plastic funnel. Gentle washing of the material from the sieve may be required. Once completed all equipment used in sieving should be cleaned.

Site number should be written more than once upon labelling. Labelling should be on lid and sides of bucket, not just the lid. Labelling should include the survey area, job No & job title/code and date. A plastic label should also be placed inside the sample with the same details.

Formalin is added to these samples at a later stage (see Rules for Formalin use, Section 1.3.6.4).

Beam Trawls and Scallop Dredge

General

Samples obtained using the beam trawls and dredge should be spread out in order to assess overall character. Photographic records should be made for future reference or checking of sediment characteristics. Photographs of the entire trawl shall be taken and also any sub-samples taken. Full details of date, sample number, sub-sample number, etc. should be included in the photograph.

Notes should be made on sediment characteristics, shell material content and algal abundance, according to the scales detailed below. Either the scale value should be noted or the characteristic attached to it.

Sediment Character Scale

1 = Mud
2 = Sand
3 = Granules 2 - 4 mm
4 = Gravel/pebbles 4 - 64 mm
5 = Cobbles 64 - 120 mm
6 = Stones/boulders > 120 mm

Shell Material Scale

1 = 20% of sediment is shell
2 = 40% of sediment is shell
3 = 60% of sediment is shell
4 = 80% of sediment is shell
5 = 100% of sediment is shell

Algal composition of trawl should be measured on a scale of 1 - 100%.

Other observations that should be recorded include the presence of egg-cases (e.g. dogfish, rays, cuttlefish.

2m Epibenthic Beam Trawl on-board sample processing

The following procedures are based on CEFAS guidance (RAC, 2003).

Having made the general records of sample character the following detailed methods should be employed:

1. Measure the volume of the total sample using a graduated fish box. Estimate the percentage of the sample which comprises large boulders. These should then be removed and washed over a 5mm grid mesh on a sorting table to remove mobile fauna. The solitary attached fauna should be enumerated from these boulders while the readily identifiable encrusting fauna should have their abundance estimated (based on the whole sample) using the percentage element of the SACFOR scale. These boulders may then be disposed of, although any taxa of doubtful identity should be returned to the laboratory for identification.
2. Measure the volume of the remaining catch, using a graduated fish box. Note the volume, photograph and then mix the sample.
3. Collect a sub-sample, from the fish box, of known volume. As a guide this should be between 5 and 10 litres. This sub-sample should be sorted into temporary storage containers, based on each taxa found.

4. For numerous taxa (>100 individuals) the number found should be recorded in relation to the volume of sub-sample it was collected from. Use the following format:

   Buccinum undatum - 125 collected from a 5 litre subsample in a 37 litre total sample.

5. The total abundance in the whole sample can therefore be estimated from this count. (37/5)*125 = 925. This taxon may then be ignored in the remaining sample.
6. For lower abundance taxa (<100 individuals) in the first sub-sample, a further measured sub-sample should be collected. The counts of the lower abundance taxa in the subsequent sub-samples should be cumulative, i.e. added to the previous count. A cumulative volume is also required so that the same calculation as in 4 above can be made, e.g.

   Ophiura ophiura – 57 +49 individuals from 5 + 6 litres in a total 37 litre sample.

   i.e. (37/11)*106 = 356.

7. The field based sub-samples are only required for highly numerous taxa and it is suggested that a maximum of 2 sub-samples is sorted in the field, accounting for a maximum of 33% of the total sample. Any remaining clearly evident taxa should be counted from the total sample. An additional, sub-sample of the fauna (5 litres) should be retained so that all taxa, including those not immediately evident, can be identified in the laboratory. The same principle for estimating total abundance to that above will apply.
8. *Sabellaria spinulosa* should be treated as a special case if it occurs in a reef/nodular form. A measurement of sample volume should be made using a volume displacement method (Eureka can). It should be noted that any sites where *S. spinulosa* occurs in abundance will generally not be suitable for re-sampling in subsequent years.

Measurements of commercially important species should be obtained as indicated in subsequent sections. See also Table 2. for a list of priority epibenthic species for the EEC.

4m Beam Trawl Catch Sorting – Fish

All fish (both commercial and non-commercial) and commercial shellfish should be sorted and removed from the catch. The following species are considered commercial shellfish and should be recorded in samples from the ECA:

Lobster *Homarus gammarus*
Edible crab *Cancer pagurus*
Spider crab *Maja squinado*
Common whelk *Buccinum undatum*
Scallop *Pecten maximus*
Queen scallop *Aequipecten opercularis*
Cephalopods: all squid, octopus and cuttlefish to species level

All species of fish (except sand gobies, which can be aggregated as Pomatoschistus spp.) should be identified to species level, using standard identification keys (see below), and sampled according to the methods described in the following section.

Wheeler, A. (1969). The fishes of the British Isles and North West Europe. Michigan State University Press, 613pp.

Wheeler, A. (1978). Key to the Fishes of Northern Europe. Frederick Warne, London. 380pp.

Whitehead, P.J.P., Bauchot, M.L., Hureau, J.-C., Nielsen, J. and Tortonese, E. (Eds.) (1984). Fishes of the North-eastern Atlantic and the Mediterranean, Vol. 1-3. UNESCO, Paris, 1473pp.

Any unusual species, or specimens for which there is some doubt, should be retained and identified on land.

4m Beam Trawl Measuring and Counting

The total length of all fish should be measured to the centimetre below (i.e. 24.0cm to 24.9cm are classed as 24cm). Total length is the distance from the tip of the snout to the tip of the caudal fin. Plaice, sole and all elasmobranchs (dogfish, rays) should be measured separately for males and females.

Edible crab should be measured (using three categories: male; unberried female; berried female) to the neared millimetre carapace width (see Fig. 1)

Lobster and spider crab should be measured (using three categories: male; unberried female; berried female) to the neared millimetre carapace length (see Figs 2 and 3)

Whelk should be measured to the neared millimetre shell height.

Scallop and queen scallop should be measured to the neared millimetre shell height (breadth), which is the distance from the dorsal hinge line to the opposite margin of the shell.

Squid and cuttlefish *Sepia* spp. should be measured to the centimetre below (mantle length)

Octopus and cuttlefish of the genera *Rossia*, *Sepiola* and *Sepietta* do not need to be measured, although they should be counted. Though such species are not commercial, they are included in this section to minimise the likelihood of small individuals of Sepia spp. being overlooked in sampling.

If any given species of fish/shellfish is very abundant (>100 individuals) and it is impractical to measure all individuals, then this species may be sub-sampled. In such cases, the following procedure should be undertaken. Firstly, ascertain whether all individuals are within a restricted size range. If there are a few very small and/or very large individuals, these should be removed, and those size classes comprising few individuals measured completely. For those size classes with a large number of individuals, the total weight should be recorded, a random sub-sample (at least 100 fish) of known weight taken, and all fish in the sub-sample measured. These data (numbers and size distribution) can be subsequently raised to the total catch (see 2m epibenthic trawl method).

Figure 1 Measurements for edible crab

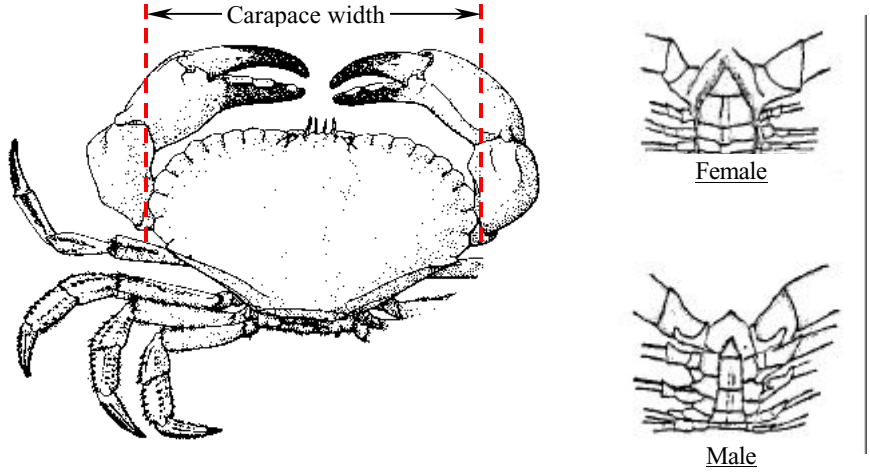


Figure 2 Measurements for lobster

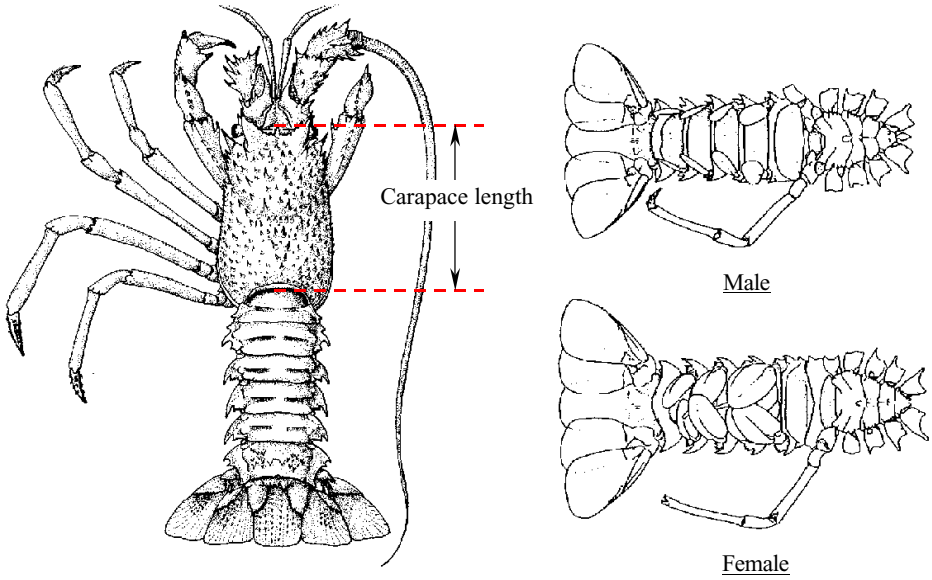
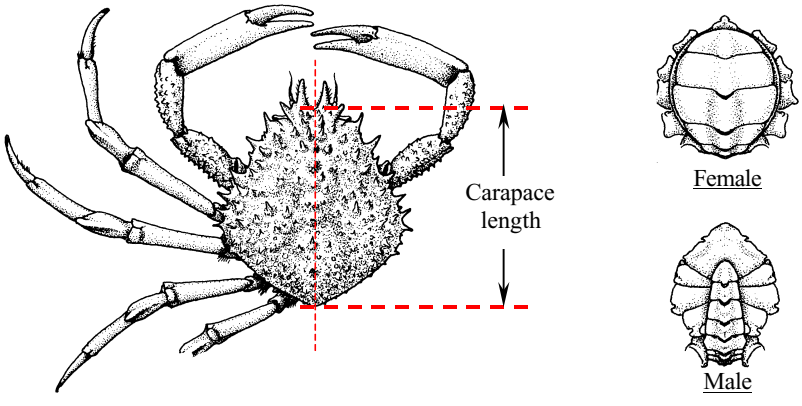


Figure 3 Measurements for spider crab



4m Beam Trawl Catch Sorting – Epibenthos

The abundance of the epifaunal species listed in Table 2 should be obtained. This list includes species that are regularly reported from sampling in the eastern English Channel with beam trawls, and that are effectively sampled with 4m-beam trawl. This list also contains additional species that are rarely, if at all, reported from the area, but are of high importance regarding marine nature conservation issues.

Table 2 Priority epibenthic species from the EEC

Species	Count	Weigh	Rationale
Pink seafan *Eunicella verrucosa*	✓ (colonies)	✓	Unlikely to occur in eastern Channel, but this species is protected under the Wildlife and Countryside Act (WCA)
Dead mans fingers *Alcyonium digitatum*	-	✓	Abundant sessile species
Sea mouse *Aphrodita aculeata*	✓		Typical of inshore sandy habitats
Sea mouse *Hermione hystrix*	✓		Regularly occurs on coarse offshore grounds
+*Sabellaria spinulosa*	-	✓	Of marine nature conservation interest. Should include sand tubes in measurement.
Common hermit crab *Pagurus bernhardus*	✓	-	Typical of inshore sandy habitats
Hermit crab *Pagurus prideaux*	✓	-	Regularly occurs on coarse offshore grounds
Sponge crab *Dromia personata*	✓	-	Southerly species
Spider crabs (Majidae, identified to species level)	✓	-	Included to ensure that juvenile *Maja squinado* are not overlooked
Round crab *Atelecyclus rotundatus*	✓	-	Regularly occurs on coarse offshore grounds
Masked crab *Corystes cassivelaunus*	✓	-	Typical of inshore sandy habitats
Swimming crab *Liocarcinus holsatus*	✓	-	Typical of inshore sandy habitats
Harbour crab *Liocarcinus depurator*	✓	-	Regularly occurs on coarse offshore grounds
Marbled swimming crab *Liocarcinus marmoreus*	✓	-	Regularly occurs on coarse offshore grounds
Velvet swimming crab *Necora puber*	✓	-	Of some commercial importance
Gastropods (identified to species level)	✓	-	Potentially sensitive to dredging
Ocean quahog *Arctica islandica*	✓	-	Of marine nature conservation interest
Fan mussel *Atrina fragilis*	✓	-	Unlikley to occur in eastern Channel, but this species is protected under the WCA.

Species	Count	Weigh	Rationale
Bivalves (identified to species level)	✓	-	Potentially sensitive to dredging
Bloody Henry starfish *Henricia oculata*	✓	-	Regularly occurs on coarse offshore grounds
Red cushion star *Porania pulvillus*	✓	-	Regularly occurs on coarse offshore grounds
Goosefoot starfish *Anseropoda placenta*	✓	-	Regularly occurs on coarse offshore grounds
Common sunstar *Crossaster papposus*	✓	-	Regularly occurs on coarse offshore grounds
*Common starfish *Asterias rubens*	✓	✓/-	Common and widespread
Common urchin *Echinus esculentus*	✓	-	Occasional on coarse offshore grounds in the area
Green sea urchin *Psammechinus miliaris*	✓	-	Regularly occurs on coarse offshore grounds
Purple heart urchin *Spatangus purpureus*	✓	-	Regularly occurs on coarse offshore grounds
Sea potato *Echinocardium* spp.	✓	-	Typical of inshore sandy habitats
Brittlestar *Ophiura ophiura*	✓	-	Typical of inshore sandy habitats
*Common brittlestar *Ophiothrix fragilis*	✓/-	✓/-	Regularly occurs on coarse offshore grounds
Curly weed *Alcyonidium diaphanum*	-	✓	Common and widespread
Hornwrack *Flustra foliacea*	-	✓	Regularly occurs on coarse offshore grounds. Increases structural complexity
Ross coral *Pentapora foliacea*	✓ (colonies)	✓	Potentially sensitive to dredging. Increases structural complexity
Cellaria spp.	-	✓	Potentially sensitive to dredging. Increases structural complexity
+ *Sabellaria* measurement should comprise of a measure of volume rather than weight, with a photographic record of the samples. If coherent reef structure is sampled it is unlikely that the site will be suitable for re-sampling in the following year. **O. fragilis* and *A. rubens* can sometimes be very abundant, and so full enumeration may not be possible. In these circumstances it is recommended that an alternative metric is used (e.g. total weight, number of baskets etc.)			

Individuals/colonies of all species should be sorted from the catch and identified at sea or preserved for subsequent identification. Records of these should be numerical or by weight. For colonial encrusting species data should be presence absence only. These data are to be presented as a species list in taxonomic order. This list will allow a detailed inventory of species present in the area to be documented, which is an important component of biodiversity monitoring. It is also the most pragmatic method for monitoring the presence of sessile fauna (hydroids, bryozoans, sponges etc.) that are ecologically important in terms of increasing structural complexity on the sea floor, and will include several taxa that would be sensitive to the effects of dredging

Other observations that should be recorded include the presence of egg-cases (e.g. dogfish, rays, cuttlefish), any information on sediments (e.g. rocks, shell debris that was retained by the net), and the presence of any litter.

Scallop Dredge Sample processing

The priority species in the scallop dredges are the scallop species *Pecten maximus* and the Queen scallop *Aequipecten opercularis*.

Total catch for both species will be counted. Scallop and queen scallop should be measured to the nearest millimetre shell height (breadth), which is the distance from the dorsal hinge line to the opposite margin of the shell.

If either species is very abundant (>100 individuals) and it is impractical to measure all individuals, then the species may be sub-sampled. In such cases, the following procedure should be undertaken. Firstly, ascertain whether all individuals are within a restricted size range. If there are a few very small and/or very large individuals, these should be removed, and those size classes comprising few individuals measured completely. For those size classes with a large number of individuals, the total weight should be recorded, a random sub-sample (at least 100 specimens) of known weight taken, and all shellfish in the sub-sample measured. These data (numbers and size distribution) can be subsequently raised to the total catch (see 2m epibenthic trawl method).

Other commercially important fauna should be noted from the dredge based on the methods given for the 4m beam trawl. Epibenthic species should be recorded on the basis of the SACFOR scale from the whole sample, with any taxa of doubtful identity retained for laboratory analysis. The species list (Table 2) should be used as a guide to potentially important or significant species in the EEC.

3.3.6.2. Sample Preservation, Storage and Transport

As it is anticipated that samples may be stored on board, in formalin, operations must observe the following:

Use of formalin should follow the required safety management procedures. Contractors shall provide documentation related to their companies operating procedures for the use of formalin.

Contractors must ensure that all work undertaken with formalin is carried out bearing in mind the following requirements:

- **Wear protective clothing (such as a fastened lab coat or overalls).**
- **Wear safety spectacles or a full face mask.**
- **Wear protective gloves.**
- **Take great care to avoid inhalation of fumes.**
- **If contact with skin occurs wash thoroughly with water. If spills occur, dilute with plenty of water.**
- **Always wash hands thoroughly after use.**
- **Always use formalin in a well - ventilated area, preferably a fume cupboard or outside away from buildings and people**

Care should be taken in the disposal of empty containers. Ensure all containers are suitably labelled with the concentration (expressed as %w/v). Always store formalin (and samples containing formalin) in a secure ventilated storage area.

Preservation and Storage of Faunal Samples

Formalin will be added to the faunal samples obtained as soon as possible following collection. Formalin at 40% w/v is added to the seawater already covering the samples until an approximate dilution to 4% w/v is obtained. If unbuffered formalin is used, di-sodium tetraborate should be added to the sample at a ratio of 1.5g/l to prevent the leaching of calcium from shell material within the sample.

The samples collected should be registered on return to the laboratory in a registration system. Each site shall be allocated a unique registration number and notes on the number of replicates, survey and job number together with date taken, sampler, and who registered samples, analyses required and other notes are recorded in the book and codes written on buckets.

Grab samples (and trawl samples containing fine material) shall be stained with Rose Bengal. This turns animal protein red and aids the sorting process. Very little stain is required for most samples (<0.2g). Over staining will hinder identification of the samples. Once stain and formalin have been added, samples should be stored in a cool, well ventilated and secure area. Finally a check on the labels on and in all pots should be made to avoid later confusion.

Transport of Samples

Contractors should make provision to safely deliver the benthic samples to the laboratory where analysis and enumeration will be carried out.

4. Field Reporting

4.1. Data

4.1.1. Data Delivery Formats

Equipment and methods used during types of survey described above should yield the following data, in the formats described:

- **Navigation/Positioning**

Datum
Projection
Lat/Long (easting/northing)
Time and Date (UTC)

- **Tidal Correction**

Time and date – format as for Navigation output
Gauge Position - format as for Navigation output
Depth - metres

- **CTD Calibration**

Time and date – format as for Navigation output
Navigation/Positioning output
Conductivity – PSU, mg/l
Temperature - centigrade
Depth - metres

- **Echo Sounder**

Navigation/Positioning output
CTD Calibration output
Depth – metres (reduced to CD)
Data Samples - XYZ relative to easting/northing (georeferenced)

- **Swath**

Navigation/Positioning output
CTD Calibration output
Depth – metres (reduced to CD)
Data Samples - XYZ relative to easting/northing (georeferenced)

- **Sidescan Sonar**

Navigation/Positioning output
CTD Calibration output
Sonogram – digital (either xtf or CODA format) and paper copy

- **Hamon Grab**

Navigation/Positioning output
Sample ID – individual ID marker – in spreadsheet (excel)
Sample Character Notes – text descriptions in spreadsheet (excel)
Sample Processing Notes – text descriptions in spreadsheet (excel)

- **2m Trawl**

Navigation/Positioning output
Sample ID – individual ID marker – in spreadsheet (excel)
Sample Character Notes – text descriptions in spreadsheet (excel)
Sample Processing Notes – text descriptions in spreadsheet (excel)

- **4m Trawl**

Navigation/Positioning output
Sample ID – individual ID marker – in spreadsheet (excel)
Sample Character Notes – text descriptions in spreadsheet (excel)
Sample Processing Notes – text descriptions in spreadsheet (excel)

- **Scallop dredge**

Navigation/Positioning output
Sample ID – individual ID marker – in spreadsheet (excel)
Sample Character Notes – text descriptions in spreadsheet (excel)
Sample Processing Notes – text descriptions in spreadsheet (excel)

- **Video**

Navigation/Positioning output
Station or transect ID – individual ID marker – in spreadsheet (excel)
Video files – dat files – file annoted with transect/drop position ID

- **Still Camera**

Navigation/Positioning output
Station ID – individual ID marker – in spreadsheet (excel)
Photo files – commonly accepted image file formats (jpeg, tiff, etc)

4.1.2. Data Management and Control

Both paper records and CD ROM digital media records produced and shall be labelled (where appropriate) with the following minimum information:

- **ECA name**
- **Contractor Name**
- **Contractors project reference/number**
- **Date/time**
- **Line/Station no(s).**
- **Equipment used;**
- **First and last fix number;**
- **Recorder range/scale;**
- **Scale line interval; and**
- **Operational parameters (eg. filters etc.)**

All times recorded during this survey may be either UTC (GMT) or local times. Local time should be referenced to UTC on supporting documentation.

A survey line number system convention will be agreed with ECA.

During acoustic surveys, sufficient run-in and run-out for lines should be undertaken to ensure full comprehensive coverage of the area to be surveyed.

Horizontal control and presentation of the surveys shall be provided by co-ordinates based on the following geodetic and mapping parameters:

- Datum : (to be inserted)
- Spheroid
- Projection

Unless otherwise specified, water depths for the survey shall be referenced to Lowest Astronomical Tide (LAT) and depths/heights shall be quoted in metres and/or milliseconds two-way (TWT).

Blank