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MarLIN
The Marine Life Information Network for Britain & Ireland

ENGLISH CHANNEL TOWED SLEDGE SEABED IMAGES.
PHASE 1: SCOPING STUDY AND EXAMPLE ANALYSIS.

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MESH MAPPING EUROPEAN SEABED HABITATS

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Report to the Joint Nature Conservation Committee

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English Channel towed sledge seabed images. Phase 1: scoping study and example analysis.

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English Channel towed sledge seabed images. Phase 1: scoping study and example analysis.

EXECUTIVE SUMMARY

During the 1970’s and 1980’s, the late Dr Norman Holme undertook extensive towed sledge surveys in the English Channel and some in the Irish Sea. Only a minority of the resulting images were analysed and reported before his death in 1989 but logbooks, video and film material has been archived in the National Marine Biological Library (NMBL) in Plymouth. A scoping study was therefore commissioned by the Joint Nature Conservation Committee and as a part of the Mapping European Seabed Habitats (MESH) project to identify the value of the material archived and the procedure and cost to undertake further work.

The results of the scoping study are:

1. NMBL archives hold 106 videotapes (reel-to-reel Sony HD format) and 59 video cassettes (including 15 from the Irish Sea) in VHS format together with 90 rolls of 35 mm colour transparency film (various lengths up to about 240 frames per film). These are stored in the Archive Room, either in a storage cabinet or in original film canisters.

2. Reel-to-reel material is extensive and had already been selectively copied to VHS cassettes. The cost of transferring it to an accepted ‘long-life’ medium (Betamax) would be approximately £15,000. It was not possible to view the tapes as a suitable machine was not located. The value of the tapes is uncertain but they are likely to become beyond salvation within one to two years.

3. Video cassette material is in good condition and is expected to remain so for several more years at least. Images viewed were generally of poor quality and the speed of tow often makes pictures blurred. No immediate action is required.

4. Colour transparency films are in good condition and the images are very clear. They provide the best source of information for mapping seabed biotopes. They should be scanned to digital format but inexpensive fast copying is problematic as there are no between-frame breaks between images and machines need to centre the image based on between-frame breaks. The minimum cost to scan all of the images commercially is approximately £6,000 and could be as much as £40,000 on some quotations. There is a further cost in coding and databasing each image and, all-in-all it would seem most economic to purchase a ‘continuous film’ scanner and undertake the work in-house.

5. Positional information in ships logs has been matched to films and to video tapes. Decca Chain co-ordinates recorded in the logbooks have been converted to latitude and longitude (degrees, minutes and seconds) and a further routine developed to convert to degrees and decimal degrees required for GIS mapping. However, it is unclear whether corrections to Decca positions were applied at the time the position was noted. Tow tracks have been mapped onto an electronic copy of a Hydrographic Office chart.

6. The positions of start and end of each tow were entered to a spread sheet so that they can be displayed on GIS or on a Hydrographic Office Chart backdrop. The cost of the Hydrographic Office chart backdrop at a scale of 1:75,000 for the whole area was £458 incl. VAT.

7. Viewing all of the video cassettes to note habitats and biological communities, even by an experienced marine biologist, would take at least in the order of 200 hours and is not recommended.

8. Once colour transparencies are scanned and indexed, viewing to identify seabed habitats and biological communities would probably take about 100 hours for an experienced marine biologist and is recommended.

9. It is expected that identifying biotopes along approximately 1 km lengths of each tow would be feasible although uncertainties about Decca co-ordinate corrections and exact positions of images most likely gives a ±250 m position error. More work to locate each image accurately and solve the Decca correction question would improve accuracy of image location.

10. Using codings (produced by Holme to identify different seabed types), and some viewing of video and transparency material, 10 biotopes have been identified, although more would be added as a result of full analysis.

11. Using the data available from the Holme archive, it is possible to populate various fields within the Marine Recorder database. The overall 'survey' will be 'English Channel towed video sled survey'. The 'events' become the 104 tows. Each tow could be described as four samples, i.e. the start and end of the tow and two areas in the middle to give examples along the length of the tow. These samples would have their own latitude/longitude co-ordinates. The four samples would link to a GIS map.

12. Stills and video clips together with text information could be incorporated into a multimedia presentation, to demonstrate the range of level seabed types found along a part of the northern English Channel. More recent images taken during SCUBA diving of reef habitats in the same area as the towed sledge surveys could be added to the Holme images.

English Channel towed sledge seabed images. Phase 1: scoping study and example analysis.

1. INTRODUCTION

Video and 35 mm stills cameras mounted on towed sledges have been widely used to survey areas of level seabed and rocky reefs. They can provide a clear view of habitat type and conspicuous epibiota. During the 1970's and 1980's, the late Dr Norman Holme undertook extensive towed sledge surveys in the English Channel and some in the Irish Sea. Only a minority of the resulting images were analysed and reported before his death in 1989**.**

Following 5 years developmental work at Plymouth, the MBA commenced surveying in the summer of 1976 off the south coast of Devon and Cornwall. These areas are important fishing grounds for *Pecten maximus* and *Aequipecten* (=*Chlamys*) *opercularis*. The video tapes from the 1976 cruise provided extremely useful information on pectinid abundance and distribution. Surveying was concentrated in the area covered by ICES Statistical Rectangle ZZ 99.

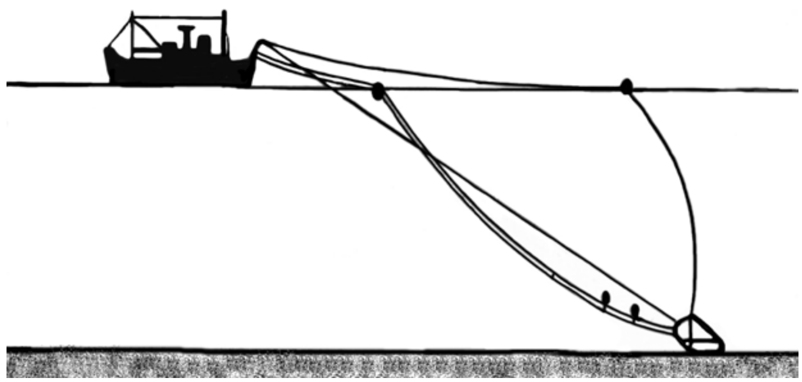

Figure 1. Deployment of the towed photographic sledge. From: Holme & Barrett (1977).

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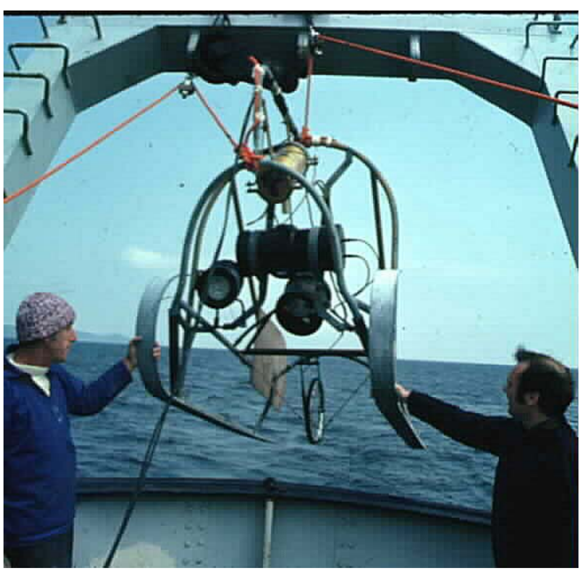

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Plates 1 and 2. Towed sledges used in the photographic surveys: 1) 1977; 2) 1984.

The way that the equipment was deployed is illustrated in Figure 1 and the two photographic sledges used in the work undertaken by Holme are shown in Plates 1 and 2. The equipment that Holme used changed as technology evolved. During initial television surveys (Holme & Barrett, 1977) a video and a still camera were mounted on top of a sled at 60cm above the sea floor. The television camera pointed forwards at an angle of 45° while the still camera pointed vertically downwards. The TV image covered had a central field width of 45.6cm and, as with any other forward pointing image, covered an area trapezoid in shape. The still camera gave an image of an area 56.7cm x 38cm. The surface area visible was approximately 0.2m². Later the angle of the TV camera was changed to either 26° from the vertical or 35° from the vertical giving a smaller frame size and better resolution of small animals. The protocol for the collection of still images was also variable. Initially a photograph was taken as a response to sighting of an interesting target on real-time video display. Later, photographs were taken every 20-30 seconds.

The distance covered by the sledge was measured by an odometer wheel. Each revolution of the wheel was 1.2m. For each revolution, an electronic bleep or ping is recorded on the soundtrack of the video. Each survey was a number of pre-determined transect lines chosen for convenience to run along selected Decca Navigator green lanes running north-south off the coasts of Cornwall to Dorset. Towing speed was slow at between ½ and 1 knot (0.257-0.514m/s). This was required for good TV picture definition. The ship's position was plotted every 5 minutes using Main Chain Decca (SW Britain Chain 1B).

Tows normally lasted several hours and the towing vessel mainly navigated against the tide along Decca Chain lines. Video tapes ran for 60 minutes, so there were several tapes used in each tow. Still photos were taken automatically during tows at regular intervals. Each tow lasted for a maximum of three hours, then the sledge was raised to change batteries and reload film. Photos taken during surveys each represent approximately 0.2m² of the sea bed. Coverage was estimated to be 1/40th that of TV record. During a 3 hr tow, the sledge might be on the bottom and recording for a period of 2.5hrs. If the distance covered was 3.5km in this time, the area of sea-bed scanned by TV camera would be 1600m². If photos were taken every 40 seconds, 225 pictures each of 0.2m², covering 45m² and space 15.6m apart, will have been exposed (Holme & Barrett, 1977).

The photographic film was marked with pvc tape so that pictures could be matched with the ship's position and with the videotape record. A title card was photographed on deck at the beginning of each tow, and during a tow, the film was marked every 50 exposures by taking 2 or 3 frames in quick succession. Subsequent frames are dark as the flash had not recycled.

Following the location and basic cataloguing of source material, some inspection of the material was undertaken and reported to MAFF in 2001as a part of a wider project concerned with long-term data sets. The 2001 study, together with some cataloguing and organising of logbooks undertaken by Keith Hiscock and Mike Kendall at the same time, established that the material was intact. Nevertheless, when the current study was commenced, there was uncertainty about where the video cassettes were and it transpired that they had been moved from a laboratory (not library) store to the off-site warehouse.

2. AIMS OF THE STUDY

The purpose of the study was to:

1. Locate, inspect, organise and catalogue the data holdings (photographic images, VHS video, reel-to-reel video, ships logs).
2. Undertake inspection of photographic holdings.
3. Match ships logs (requiring converting Decca co-ordinates to latitude and longitude) and charted information to plot locations of towed-sledge transects on electronic charts.
4. Identify prospects for data analysis including amount of time required.
5. Revise objectives.
6. Match images (rolls of 35mm transparencies) to charted positions.
7. Identify species and habitats (sediment type) in images to see level of information that can be entered to Marine Recorder.
8. Map, as far as possible, the different habitat and community types identified.
9. Enter information to Marine Recorder.
10. Scan 35 mm images to electronic media.
11. Consider if VHS material should be saved to digital media and cost.
12. Report including summaries of information obtained and examples of images. A CD-ROM of images also to be provided.

3. VIDEOTAPE, VIDEOCASSETTES AND PHOTOGRAPHIC TRANSPARENCIES ARCHIVE

3.1 Archive holdings

The MBA archives hold 106 videotapes (reel-to-reel Sony HD format) and 59 video cassettes (including 15 from the Irish Sea) in VHS format together with 90 rolls of 35 mm colour transparency film. These are stored in the Archive Room of the National Marine Biological Library in Plymouth. There are also 21 tapes from a 1971 BBC expedition to the Comoros Islands and 4 videotapes from dives made in the English Channel in 1971 in the submersible Pisces. It is believed (R. Barrett, pers. comm.) that some reel-to-reel tapes were discarded during a warehouse clear-out. In the notes that follow only the material relating to the English Channel will be described.

3.2 Reel-to-reel videotapes

Videotapes are from the period 1976 to 1980 and were recorded at stations from Cornwall to the Isle of Wight. The original tapes are Sony high density videotape (V-62) for helical scan videotape recorders. Eight tapes are from the Breton coast of France. It has not been possible to review these reel-to-reel tapes as the MBA no longer hold a machine capable of playing old-format video. In 2001, contact was made with staff at BBC Bristol who were confident that it would be possible to find a company to do transcription at commercial rates. A small number of video records from 1976 have been transcribed on to videocassette. As each of these cassettes is marked as containing the contents of four separate tape reels, it is assumed that the VHS tapes represent edited highlights. The VHS tapes inspected are in black and white and consequently it is assumed the same is true for the entire collection of reel-to-reel tapes. The analysis of seafloor videos recorded in Holme's notebooks contains little detail of fauna but give useful information on benthic habitats. Positions of video tows are geographically referenced.

3.3 Videocassettes

The majority of videocassettes were recorded in the years 1982 and 1984. They are in colour and those that have been reviewed are playable on a modern VHS video-recorder. Quality is generally poor in comparison to modern under-water video, mainly because of the height of camera above the sediment, uneven lighting and, often, fast and/or jerky movement of the sledge. While image discrimination is adequate for large bodied animals such as scallops, smaller species are often difficult to identify. Identification is improved when the video and still images are viewed together.

3.4 Photographic transparencies

The transparencies that have been examined are of high quality and are sufficient to make useful identifications of visible animals larger than about 5mm across. Further information can be gleaned from examination of bioturbational features, e.g. mounds created at burrow entrances.

3.5 Use of photographic & video archive

The archive of good-quality, geographically referenced transparencies is a valuable resource for anybody wishing to have information on seafloor characteristics more detailed than those provided on navigation charts. Such information is seldom available elsewhere. Precise positions for each image are unavailable, as although the start and end co-ordinates of most tows can be determined from Holme's notebooks, the exact track steered was not necessarily a straight line. In many of the areas photographed, the images on a single tow show a mainly homogeneous sea floor and it may be reasonable to extrapolate these conditions to a greater area that can actually be sampled. However, in areas where there is strong tidal scour, the bottom environment can be highly patchy and as Holme noted, 'no two tows can be regarded as replicates'. The video archive is best used in support of transparencies.

4. METHODS OF ANALYSIS AND PRESENTATION OF MATERIAL

Papers written by Holme were obtained from the MBA library and read to provide background information on his towed video sledge work.

The archive held at the library was investigated and all towed sledge logbooks separated from Holme's other projects. Data from two separate 'example' tows was transferred to an Excel spreadsheet. Decca co-ordinates from 104 English Channel tows were converted to latitude/longitude using the programme Decca Geografisch and the SW British Chain 1B, for the spreadsheet. However, this conversion method did not always produce an acceptable result. Some errors were encountered for positions off the Isle of Wight and Anvil Point. Therefore, the option of manually calculating latitude and longitude was adopted to obtain a more accurate result. This involved one person calling out and recording latitude and longitude (both start and end of tow), and another using parallel rules to locate the tow, and to read off the co-ordinates from Decca Chain 1B S.W. Britain charts. The maps used are SW Britain chain 1B/MP L (D1) 3315 Berry Head to Bill of Portland; L (D1) 2450 Anvil Point to Beachy Head; L (D1) 1267 Falmouth to Plymouth and L (D1) 1613 Eddystone Rocks to Berry Head.

Using all available log books in the archive, information was transferred to an Excel spreadsheet. The spreadsheet shows dates of the main tows, location, whether stills or video were taken and also conversion of Decca co-ordinates to latitude and longitude of the start and end positions of each tow. Again, this data can be used to plot each tow in the English Channel to show the area covered.

One Tow (Tow 6) was selected as an example to show the assortment of bottom types and associated species encountered in 12 photographs from "Film 6".

To illustrate the extent of notes made by Holme, and also the detail provided by the 35mm photographs, Film 8, Tow 8 was selected from 16 May 1982. In addition, the re-classification of bottom types, using Holme's A to H key is also shown. Using the JNCC MNCR biotope classification 04 05, Holme's categories were translated into new codes by Keith Hiscock.

Approximately 15 35 mm films were viewed rapidly by eye. Images that were available as mounted duplicates copied from the continuous films were scanned digitally to view and to include examples in this report.

5. RESULTS

5.2 Locations of tows

Holme carried out a total of 104 mainly English Channel tows between April 1975 and August 1984. Tows were carried out from off Looe in Cornwall to off Freshwater Bay in the Isle of Wight.

The image holdings are catalogued in Appendix 1.

Appendix 2 gives locations, Decca grid co-ordinates and latitude and longitude for all of the towed sledge runs as position at the start and at the end of tows. Figure 2 shows the position of all of the sledge tows. The start of each tow is shown in green, the end in yellow.

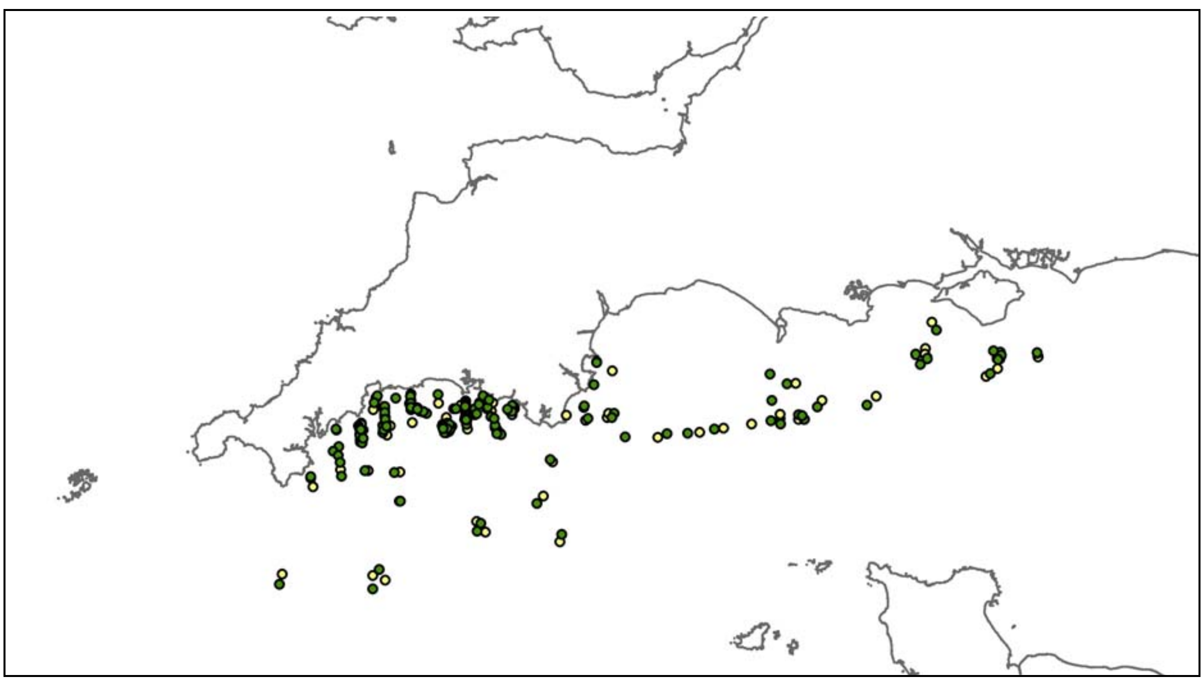

Figure 2. Map of south-west England showing location and coverage of the 104 main tows carried out by Holme between 1975 and 1984. The start of each tow is shown in green and the end in yellow.

Plotting the position of the tow throughout the deployment is very time consuming but Appendix 3 plots two tows from 1977 as example data sets. Details are given for position every 5 minutes) and depth (m). The information was used to produce maps (Figure 3) to illustrate the exact route of the tows.

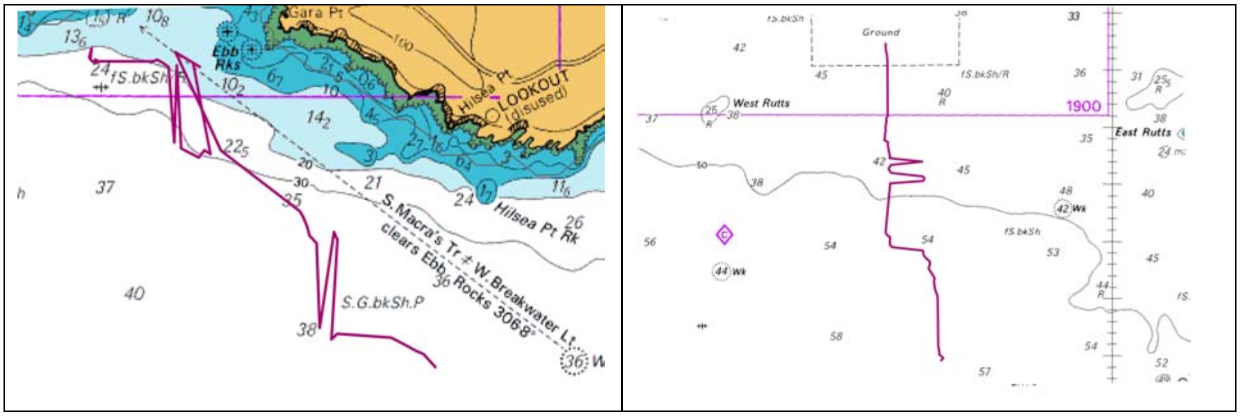

Figure 3. Chart sections of part the south Devon coast showing two selected tows from 1977. The plot gives a record of the tow location from co-ordinates logged every five minutes.

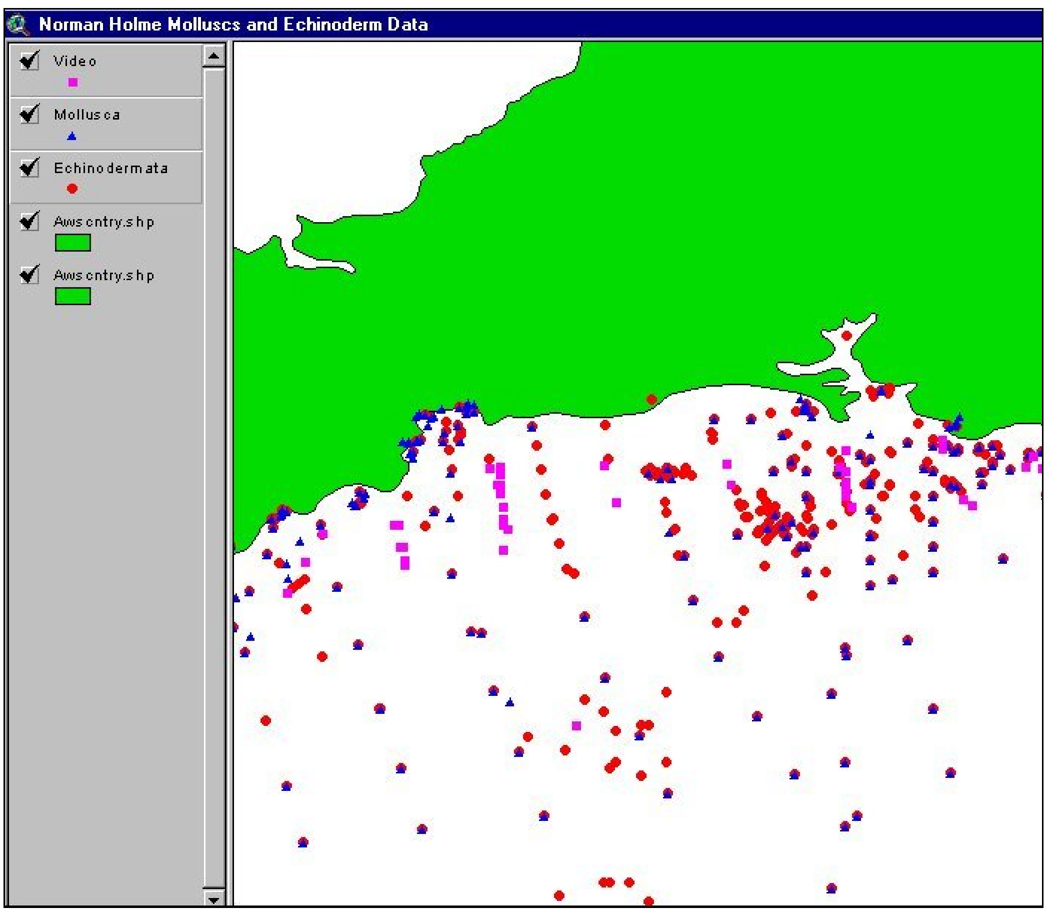

Figure 4. Towed video sledge samples in the context of other Holme surveys (GIS output from Marine Biological Association, 2001).

The map shown in Figure 4 is another example of how the Holme archive data can be used. This GIS plot of sampling sites for mainly Mollusca and Echinodermata was constructed for a MAFF report on fishing effort and climate change (MBA, 2001).

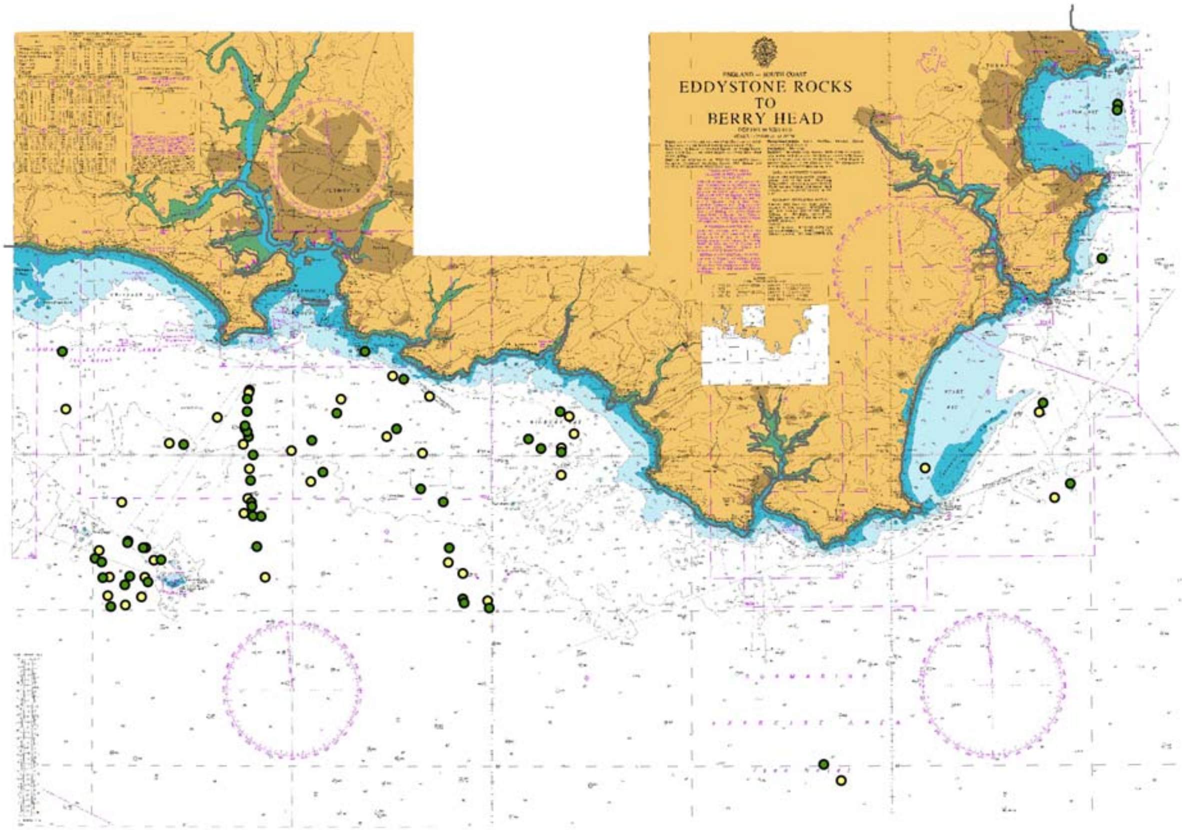

Figure 5. Tows mapped onto Hydrographic Office Chart 1613 backdrop. Tow start (green) and end-points (yellow) only are shown.

We used an existing MBA-licensed electronic chart to test and demonstrate how the towed sledge positions would map onto a chart backdrop as a GIS layer. The results are illustrated in Figure 5. The tow positions appear to broadly match the expected depths on the chart. We also enquired of the cost to supply a chart backdrop for all of the relevant English Channel seabed from SeaZone. Further information available along the tow lines will include links to images and associated descriptions of the seabed at certain points.

5.2 Seabed types

Holme's classification of seabed types is shown in Table 1. His original sediment descriptions were based on the Wentworth scale. His classification of communities is show in Table 2.

Table 2 is the key to classification of bottom types from video analysis taken from the notebooks.

Table 1. Classification of seabed types used by Holme.

A	Non-mobile gravel - sponges encrusted rock. Hydroids. *Tealia* [*Urticina felina*] Occasional *Solaster* [*Crassoster papposus*]. *Lepralia.*[*Pentapora fascialis*].
AA	As A, but exceptionally extensive growths of sponges etc indicating undisturbed bottom.
B	Gravel – essentially non-mobile, but growths of sponge absent/scarce. May possibly be covered by thin sand ribbons. Fauna – *Tealia* [*Urticina felina*], hydroids, *Solaster* [*Crassoster papposus*]. *Flustra.* Later divided further - see below
C	Sand and gravel - appears to be thin sand ribbon over Type B. Fauna – *Tealia* [*Urticina felina*],hydroids, *Flustra*, little else. Also used for mixed sand/gravel sediments.
D	Sand ribbons - smooth
E	Sand - ripples and waves
F	Rock outcrop - relates to A or AA unless bare.
G	Boulders - relate to A unless bare.
H	Mobile gravel - and shell gravels with no fauna.
B1	See Table 2
B2	See Table 2
B3	See Table 2

Table 2. Classification of species in seabed types based on Tow 6 (6 May 1982). Current names of species are given in [ ].

TYPE A COMMUNITY – sponges, stable

Sponges: *Haliclona viscosa* *Iophanopsis nigricans* *Terpiops fugax* *Hymedesmia versicolor* *Dysidea fragilis* (more characteristic of B1) ? *Myxilla poracea* *Hemimycale columella* **Anemones:** Unidentified e.g. white anemones *Sagartia elegans* *Sagartia troglodytes* *Cerianthus lloydi* *Actinothoe sphyrodeta* *Corynactis viridis* **Hydroids:** *Nemerteria ramosa* *Nemerteria antennina* *Kirchenpaueria pinnata* *Abetinaria abietinaria* *Sertularia cupressina / argentea* *Halecium* sp. *Theocaprus myriophyllum*	**Ascidians:** *Polycarpa pomaria* *Distomus variolosus* (characterised in large numbers on top of stones) *Pyura microcosmus* *Botryllus schlosseri* *Ciona intestinalis* ***Ascidia mentula*** **Bryozoa:** *Omalsecosa ramulosa* *Lepralia foliacea* [*Pentapora fascialis*] **Echinoderms:** *Henricia* sp. **Molluscs:** Boring in outcrop *Calliostoma* *Ocenebra erinacea* **Polychaetes:** *Salmacina dysteri* (Huxley) *Polydora* sp. ?*Pista maculata*

TYPE B-1 COMMUNITY – *Sabellaria*, *Polycarpa violacea*

Fairly stable, but more sandy then A. Sometimes classified as A/B in notes. Some overlap with Type A, but sponges much scarcer and *Polycarpa* sometimes dominant.

Sponges: *Terpiops fugax* *Dysidea fragilis* *Hymedesmia versicolor* *Haliclona viscose* *Iophonopsis nigricans* Most of the above (except perhaps *Dysidea*) occur also, more commonly in Type A *Myxilla incrustans* **Anemones:** *Tealia felina* [*Urticina felina*] **Hydroids:** *Nemertesia ramosa*	**Ascidians:** *Polycarpa violacea* *Distomus variolosus* Compound ascidians *Ascidia mentula* **Polychaetes:** *Sabellaria spinulosa* **Bryozoa:** *Lepralia foliacea* [*Pentapora fascialis*] *Vesicularia spinosa* **Echinoderms:** *Solaster papposuss* [*Crossaster papposus*]

TYPE B-2 COMMUNITY – Impoverished *Polycarpa-Flustra-Sabellaria* community

Often associated with sand. More restricted fauna, with *Flustra* characteristic among sand near edge of rocks. *Lepralia* [*Pentapora*] absent.

Sponges: Typically absent or on rocks well above sand where they compose Type A community. **Anemones:** *Tealia*[*Urticina*] *felina* **Hydroids:** *Nemertesia ramose* *Nemertesia antennina* *Abietinaria abietina* *Tubularia* sp. **Ascidians:** *Polycarpa violacea* *Ascidia mentula*	Dendrodoa grossularia **Polychaetes:** *Sabellaria spinulosa* *?Dasychone bombyx* **Crustacea:** *Hermit crab* *Barnacles* *Atelecyclus* **Bryozoans:** *Flustra folicea* *Vesicularia spinosa* **Echinoderms:** *Solaster* [*Crassoster*] *papposus* *Antedon bifida*

TYPE B-3 COMMUNITY – Barnacle extension of *Polycarpa-Sabellaria-Flustra* community

Dominated by barnacles (e.g. *Balanus crenatus*). *Pomatoceros* may also be present. May include elements of B-2 community.

Plates 3 to 14 illustrate Tow 6 Film 6. Each photograph is shown in order of succession across Tow 6 and Holme's species notes are highlighted below each plate. The location was south of Anvil Point (start tow 49.17.48.931ºN 3.18.15.664ºW, end tow 49.18.51.496ºN 3.16.44.203ºW) near Swanage, Dorset. It should be noted that images from Tow 6 were more thoroughly documented than almost all others and Tow 6 is used as an example here to demonstrate the sort of information that can be obtained from the images.

Plates 3 to 14. Selection of seabed and community types based on the classification In Table 1 and 2. The images are from Tow 6, Film 6 undertaken on 16 May 1982.

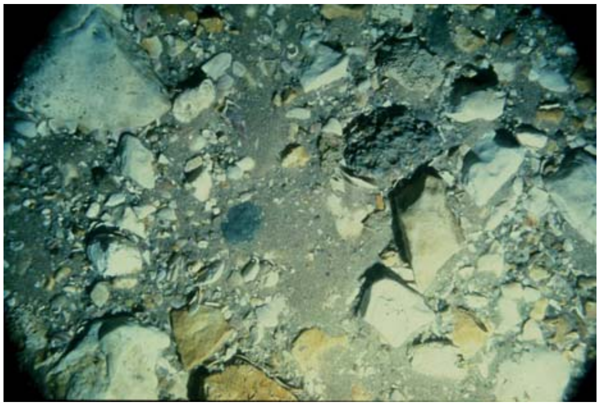

Plate 3. Frame 11. Type C. Angular stones (flints). Sand. No fauna.

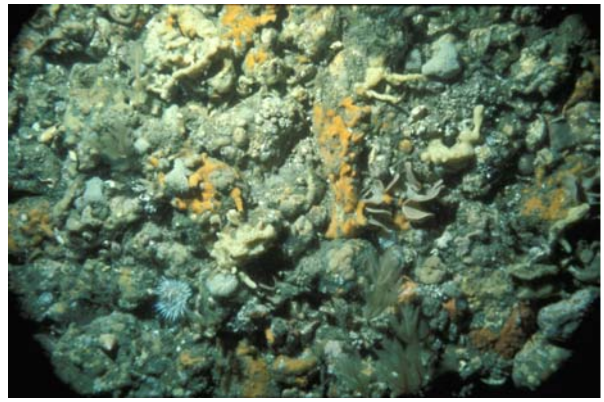

Plate 4. Frame 24. Type A. Pebble mosaic. Sand matrix. Sponges common. Several hydroids. White anemone. Several young *Pentapora fascialis*.

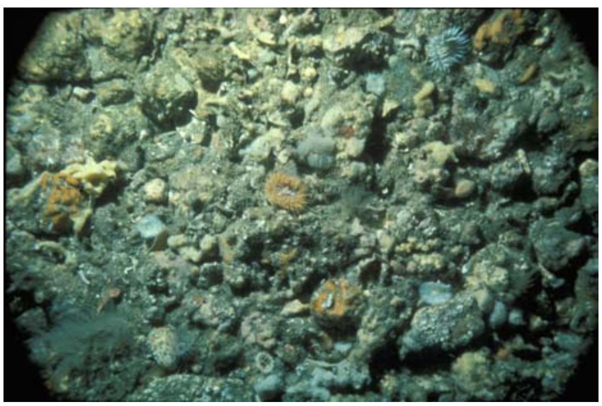

Plate 5. Frame 30. Type A. Pebbles. Matrix stabilised muddy sand. Several sponges. Assorted anemones. Hydroid.

Plate 6. Frame 49. Type F. Rock outcrops with miniature escarpment. Sponges, hydroids. Edible crab. Barnacles, serpulids, holothurian tentacle.

Plate 7. Frame 61. Type B1. Rock outcrop. Hydroids. Anemone *Urticina felina, Crossaster papposus. Pentapora fascialis*. Ascidian, *Nemertesia ramosa*.

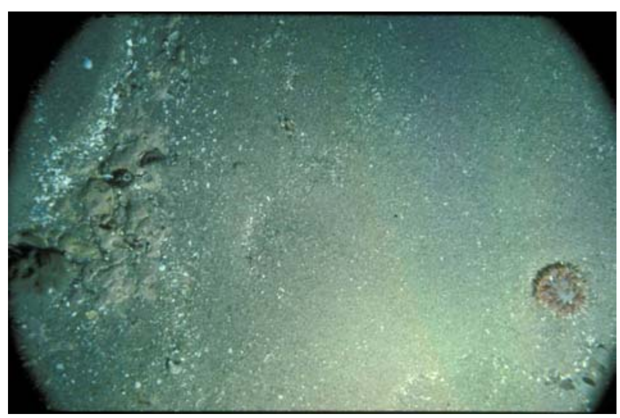

Plate 8. Frame 67. Type D. Flat sand over rock outcrop. *Urticina felina* sticking up through sand. Buried *Flustra foliacea* top left.

Plate 9. Frame 101. Type B2 and C. Sand and stones. *Flustra foliacea. Crossaster papposus.*

Plate 10. Frame 132. Type H. Shells and gravel. Probably mobile. *Modiolus, Aequipecten, Venerupis* shells. Hydroid.

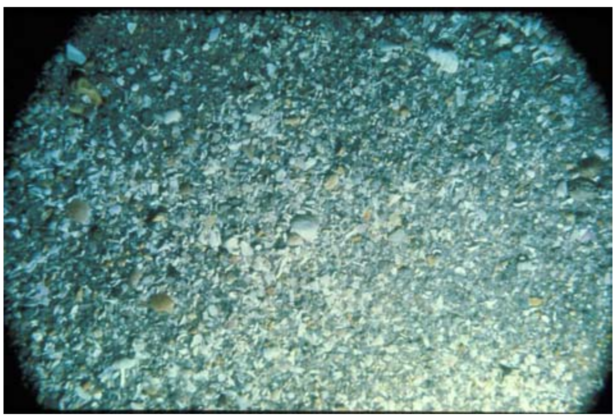

Plate 11. Frame 182. Type C. Sand containing numerous shell fragments.

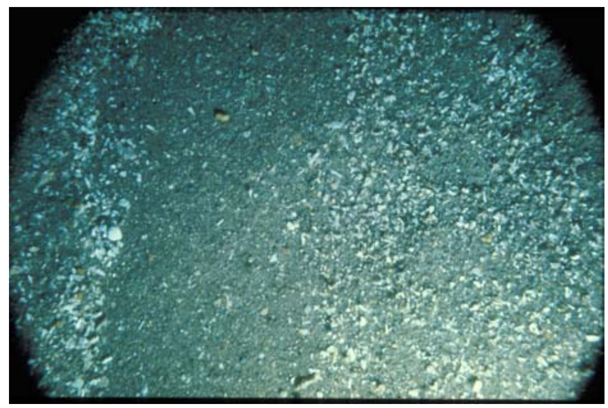

Plate 12. Frame 186. Type D. Coarse sand. Shell fragments which have linear arrangement.

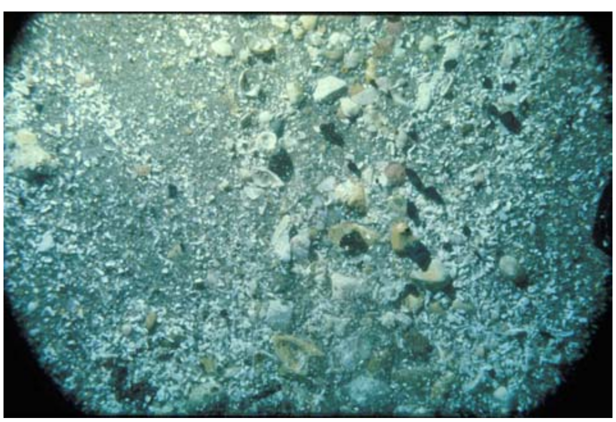

Plate 14. Frame 187. Type D. Sand, many shell fragments.

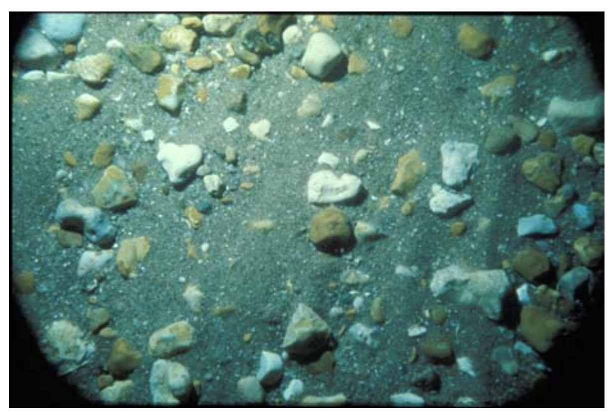

Plate 15. Frame 214. Type C. Gravel and sand. Some evidence of current action.

6. CONVERSION TO MNCR CLASSIFICATION AND INPUT TO MARINE RECORDER

Using version 04.05 Marine Habitat Classification for Britain and Ireland (Connor *et al.*, 2004), for sublittoral sediments and circalittoral rock biotopes, and referring to Holme (1966) for characterising species of sediments without epibiota, it is possible to convert Holme's categories derived from towed sledge surveys as follows:

TYPE A COMMUNITY – stable faunal assemblage with diverse sponge cover. Occurs on surface of non-mobile hard floors such as pebbles, cobbles, boulders and rock outcrops. Not subject to scour by sand or gravel nor to periodic cover by sand or gravel. = **CR.HCR.XFa.SpNemAdia Sparse sponges, *Nemertesia* spp and *Alcyonidium diaphanum* on circalittoral mixed substrata**

TYPE B-1 COMMUNITY – Well-developed faunal assemblage with *Polycarpa violacea.* Relatively stable fauna associated with pebbles, cobbles, rock outcrop and lower parts of large boulders. Periodic submergence by sand. = **CR.HCR.XFa.FluCoAs.X *Flustra foliacea* and colonial ascidians on tide swept exposed circalittoral mixed substrata**

TYPE B-2 COMMUNITY – Impoverished *Polycarpa violacea-Flustra foliacea* assemblages. Develops on pebbles, cobbles and rock surfaces subjected to considerable sand scour and/or periodic submergence by thin layers of sand. Sponges absent. = **CR.HCR.XFa.FluCoAs.X *Flustra foliacea* and colonial ascidians on tide swept exposed circalittoral mixed substrata**

TYPE B-3 COMMUNITY – Impoverished *Balanus-Pomatoceros* assemblage. Found on hard surfaces at times subjected to severe scour or deep submergence by sand or gravel. Fauna restricted to fast-growing colonizers. = **CR.MCR.EcCr.UrtScr *Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock**

TYPE C COMMUNITY – Cobble floor covered by sand or sand/gravel mixture.(furrows and ribbons). Characterised by *Sabellaria spinulosa*, *Flustra foliacea and Urticina (Tealia) felina*. = **SS.SBR.PoR Polychaete worm reefs (and sublittoral sediment)**

D Sand ribbons – smooth = **SS.SSa.CFiSa Circalittoral fine sand** (Biotopes cannot be identified from images).

E Sand - ripples and waves = **SS.SSa.CFiSa Circalittoral fine sand** (Biotopes cannot be identified from images).

F Rock outcrop - relates to A or AA (see Table 1) unless bare = Biotopes of **CR.HCR.XFa (Mixed faunal turf communities)** most likely including **CR.HCR.XFa.ByErSp.Eun (*Eunicella verrucosa* and *Pentapora foliacea* on wave-exposed circalittoral rock) and CR.MCR.EcCr.FaAlCr.Sec (*Alcyonium digitatum* with *Securiflustra securifrons* on tide-swept moderately wave-exposed circalittoral rock)** but also several others.

G Boulders - relate to A (see Table 1 and F above) unless bare = See F above.

H Mobile gravel - and shell gravels with no fauna = **SS.SCS.OCS (Offshore Circalittoral coarse sediments)**. (Inspection of grab sample data from available from various sources may help to identify represented biotopes.)

Table 2. Options for data entry to Marine Recorder from 35mm film.

OPTIONS	ADVANTAGES	DISADVANTAGES	COMMENTS
1. Biotopes for whole tow.	Can be undertaken rapidly by viewing whole film.	Different biotopes may be present along the length of the tow. Species distribution will not be indicated.	Identifying biotope requires expert eye' assessment.
2. Biotopes and species for whole tow.	As above. Species occurrence will be indicated.	As above + species locations will be general, not specific.	As above. Only a minority of the species on and in sediment will be included as most are buried or too small.
3. Biotopes and species for c1km lengths.	As above. Increased positional accuracy over the above.	Time consuming. Accuracy poor.	As above. The most likely useful precision although position would still be approximate, say ± 250m from actual.
4. Biotopes and species for precise locations (i.e. position ± c100m).	Potential to plot fine scale distribution of biotopes and species	Accuracy will be spurious because original data is not accurate location.	

Using the data available from the Holme archive, it is possible to populate various fields within the Marine Recorder database. The overall ‘survey’ will be ‘English Channel towed video sled survey’. The ‘events’ become the 104 tows. Each tow can be described as four samples i.e. the start and end of the tow and two areas in the middle to give examples along the length of the tow. These samples have their own latitude/longitude co-ordinates. These four samples would link to a GIS map. When a particular tow is clicked in these four locations, information will automatically appear from Marine Recorder regarding lat/long, species at the location, sediment type and biotope. A photograph of the seabed will also be linked in. The sample reference field could be the frame number/tow number of the photograph. The co-ordinates for a specific sample will be where the photograph was taken (details obtained from logbooks). The species list will be based on presence and absence. The depth field can also be completed, using logbook information. It is estimated that data entry for 104 tows with 4 samples per tow will take from 5 to 7 days to complete.

By viewing Film 8, Tow 8, it was possible to classify the whole tow as being represented by the CR.HCR.XFa.FluCoAs.X biotope. This is B-2 in Holme’s classification. Video cassette 2, 4 May 1976 offshore of Rame Head was also viewed and the closest biotope it represented is SS.SMU.CSaMu i.e. circalittoral muddy sand. However there are no sea pens documented as these are uncommon on the south coast.

Many of the rolls of 35mm film show similar bottom type for the majority of the tow. Therefore precise matching of position and frames is not necessary to characterise the seabed along the tow.

If option 4 was adopted, great care would be needed in plotting the position of the sledge, taking account of sledge location in relation to the vessel, Decca corrections and precise length along the film/video. Spurious accuracy is likely.

Option 3 is most favoured.

In the time available, no data was entered to Marine Recorder.

The videos give a good representation of tows but focussing is often poor and also the speed of the tow makes images difficult to view. Freeze or stop framing allows further investigation of smaller species and seabed types, but the video footage should be used as an addition to photographs and not alone. Larger animals such as brittlestars and fish were easily identifiable in many videos. For 1982 and 1984 tows in particular, Holme kept in-depth analysis of the video footage in a series of separate logbooks. This information is invaluable in helping to identify species encountered in the videos.

Each logbook took a days work to obtain the relevant information with regard to co-ordinates for each tow. Converting this to latitude and longitude took a further day per logbook. Furthermore, a meeting with Norman Revill, Skipper of RV Plymouth Quest, revealed that a correction factor had to be added to Decca co-ordinates to convert to WGS84 GPS. For red and green, 0.25 had to be added and for purple, 0.28. It is not clear from the logbooks whether Holme had already taken this in to account. We did not make any correction in plotting positions.

Matching up of stills with tow data was also time consuming. Species data located in other notebooks took a further 2 days to match to tow data and photographs (per tow).

7. ASSESSMENT OF THE TIME NEEDED FOR DIGITISING IMAGES AND FOR LINKING THEM TO GIS

The most economical way to scan the images was believed to be via a 'high street' mini-lab and a trial was undertaken at 'Priority photo-processing' in Plymouth. It was possible to quickly feed the lengths of transparency through a scanning machine. However, the end result was unsatisfactory due to the lack of breaks between each still. As each frame is circular in dimension, the separation between is a black 'egg-timer' shape. The machine tested could not recognise this as a break between frames. Further research is needed with more commercial enterprises in the hope that all transparencies can be archived on compact discs for much easier handling and viewing.

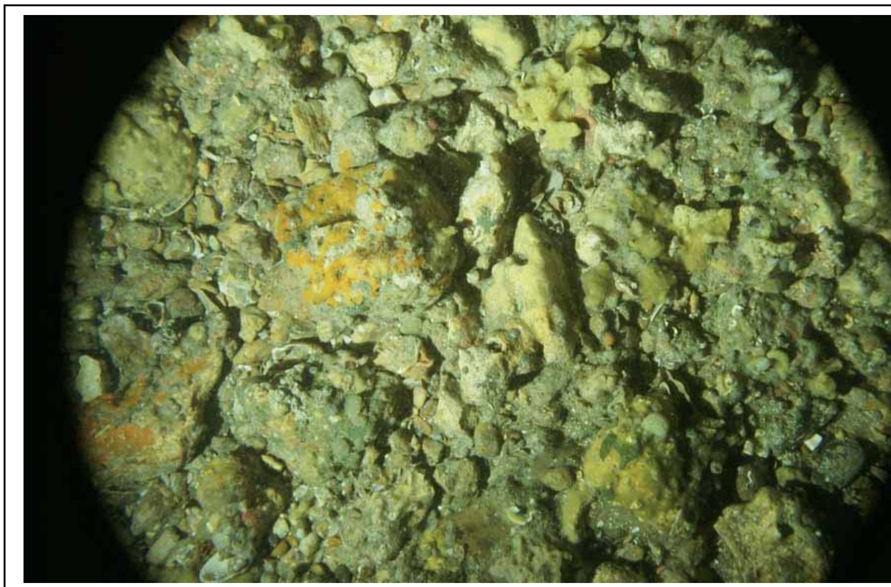

Plate 15. Frame 5, Tow 9, Film 11 on 10 May 1984 transferred to digital form by Spectrum Photographic Services in Plymouth. A significant proportion of the image has been cropped. From Holme's notebooks, it can be established that the image in

Plate 15 was taken at 49m depth, south of Anvil Point off the Swanage coast (50º 17' 4N 01º57' 6W). The image was classified by Holme as 'stable pebbles, few cobbles. Orange and yellow sponge. Type A'. Further investigation by Keith Hiscock revealed the species in the photograph to include encrusting sponges (*Esperiopsis fucorum*, possibly *Mycale macilenta, Dysidea fragilis*), *Epizoanthus couchi*, *Ocenebra erinacea*, *Calliostoma zizyphinum*, *Pomatoceros triqueter*, barnacles, possibly *Calyptera chinensis*, possibly *Botryllus schlosseri*.

Enquiries made to the Natural History Museum archive in London concluded that the only possibility may be photograph each frame individually with a high quality digital camera and flash. The same enquiries to Wildscreen, Bristol suggested using a high quality flatbed scanner to scan lengths of negative. The scan could then be opened in Photoshop and each frame saved separately. However, due to the amount of material requiring archiving, the project would be likely to take weeks and prove both time consuming and expensive. Initial trials with a flat-bed scanner, using opal glass on top of the film strip, resulted in a poor quality image. This was lightened and the contrast improved using Photoshop, but the result was still a sub-standard image. An initial test by Spectrum Photo Labs Ltd manually transferred 43 images from Film 7, Tow 9, May 1984 to compact disc. An example of one of these images is shown in Plate 15, together with species notes and location details. The cost was £13. It is estimated that, using this process to transfer all 90 films, the cost would be in the region of £6,000, although further investigations are needed including to reduce potential cost. Discussions have also taken place with Geoff Laycock of Higher Education Digitisation Services (HEDS) at the University of Hertfordshire. The 35mm film can be transferred to CD using their equipment at cost price. One film was sent for inspection and quotation. To scan at a resolution of 2,900 dpi from each frame (300 dpi at A4), the cost per frame is £2.65 plus VAT. This works out at £662.50 per 250 frame film excluding VAT, with each film taking around a week to complete. To transfer each whole 35mm archive to CD would cost around £5,000 (including discount) plus VAT. The project objective to produce a CD-ROM of images was not achieved because of the high cost of having the work undertaken externally.

The Sony reel-to-reel videotapes are more problematic, due to the equipment required. Enquiries with Stanley Productions revealed that the cost would be £120 per hour plus VAT to transfer to video cassette. Further costs will be incurred for transfer on to DVD. Further enquiries with Systems Enterprises in Durham suggested that transfer to digital Betacam would be the best option. This system is very stable and used for commercially valuable material. To transfer a single reel will cost around £85. Discussions with The Video Ark in Ealing suggest Betacam S.P. which is analogue broadcast format supported for years to come. A one-off transfer of a reel to DVD costs £150. A substantial discount is offered to transfer the whole archive of reel-to reel video's, the cost being £15,000.

Enquiries to the Southwest Film and TV Archive, based in Plymouth, provided archiving tips and recommendations. In particular, the urgency for transferring the reel-to reel videotapes before further degradation was emphasised, in view of the fact that two tapes are already infected with mould. A meeting was held on 7 March 2005 between Judith Oakley, Linda Noble (Chief Librarian, National Marine Biological Library), Elayne Hoskin (SWFTA Director) and Jenny Day (SWFTA Technical Coordinator) who gave the following comments to our queries:

"1. The 35mm films scanning should be possible to do, using one of the specialist film scanners which are available for modern PCs. These can be operated manually – in other words just like a normal page scanner in which you perform a preview scan and then "crop" the image to the area that you want. This can be rather time consuming, but it is the sort of job that can be given to a relatively unskilled person. Once they have been trained to use the software it is fairly repetitive and requires no complex activity. The cost of a suitable device is around a couple of hundred pounds.

2. When archiving any material it is never a good idea to put one's total faith in any one media or system. You should always make at least two copies using different technologies – for example one copy to DVD and the other to DVCAM tape. The reason for this is that in reality no one knows what unforeseen problems may suddenly start to develop as a particular technology ages. This can be as simple as machinery to replay the format suddenly becoming unavailable, or some previously unexpected chemical process such as that by which modern CD's are now rapidly failing due to UV light and various printing dyes eroding the plastic. Either way, all formats reach a point where the data upon them is ultimately non-recoverable. So preservation often is an exercise in running very fast just to stand still. By choosing two different technologies you will at least have a parachute as it is highly unlikely that both copies will fail in the same way or at the same time. The apparent deterioration of one medium can act as a sentry, giving advanced warning of the need to transfer the data from the other copy.

3. We hold reel to reel video replay facilities – and due to the large number of tapes already in our collection, are committed to continue doing so for the foreseeable future (at least a further ten years.) Therefore unless you are contemplating maintaining your own replay machinery then the only possible option is to donate the tapes to an archive of some sort or another. That said, once you have performed a wholesale transfer of the material to a modern format I would question the value of continuing to hold on to an original, which for reasons of unstoppable chemistry will eventually become unplayable what ever you do.

4. I have done accelerated ageing tests on all major brands of one inch videotape. By tightly controlled humidity and temperature you can hold back the ravages of time for about 40 years. But after that, pure organic chemistry means that the binder deteriorates. Consequently the best one can do for important material is to make a new master copy long before the point of no return is reached. In practice this means 15 - 30 years for tapes stored in average conditions and 40 - 50 years if they have been stored in near ideal conditions. After that there will be some data that can never be recovered and this will rapidly increase over time until total loss is reached. So given that the quality of digital video tape recording has now reached the point where the copy will be indistinguishable form the original, the question remains as to what purpose will be served in keeping the originals once one has made a new preservation copy.

5. Cleaning tape is possible in theory – we have recently been given a machine which performs this although at present we have not yet installed and tested it. You may find that what looks like mould is in fact what is known in the trade as white powder. This is actually a form of talc and is a by product of the breakdown of the original tape lubricant. However the very fact that they have mould or whatever would reinforce the concerns already expressed because the mould would be growing precisely because the process of chemical deterioration has already begun. In this case you should take fairly urgent action as the process is one of accelerating nature and is also unstoppable once started. It is not reversible in any known way. Thus although you may clean the tapes, this will not arrest the deterioration. It will merely render most but by no means all of them temporarily playable. So once cleaned they should be copied in entirety as soon as practically possible.

6. Proper storage for tape means a temperature and humidity controlled environment. In

actual fact although there are recommended maximum levels for both temperature and humidity (Very Dry and Fairly Cold) it is stability that is most important because the process by which the decomposition is started is a form of hysteresis in which water is progressively locked into the chemical structure of the tape as it is cycled through different environments. Therefore the worst possible situation is one in which the temperature and/or humidity change frequently and rapidly."

A spreadsheet or database can be provided consisting of metadata with a linked filename. For photographs, a field will be added to Marine Recorder spreadsheet to say 'image'. This will be linked to GIS. A naming convention will be established consisting of a unique key to a specific image such as frame number/tow number.

8. CONCLUSIONS

1. 35 mm film images can be matched to ships logs and laboratory notebooks to provide the best source of information about seabed types and/or biotopes. The stills pictures show finer detail than video of sediment, together with smaller animals such as echinoderms and molluscs (*Turritella*), small crabs and other Crustacea, fan worms, bryozoans, hydroids, cup-corals (*Caryophyllia*), and burrowing anemones (*Cerianthus* and *Mesacmaea*). The Holme archive contains good-quality, geographically referenced transparencies and is a valuable resource for anyone requiring information on seafloor characteristics. The information on bottom type is more detailed than that provided on navigation charts, and such information is rarely available elsewhere.

2. Videotape analysis was found to be difficult and demanding even using modern video cassettes. Between two and three hour analysis was found to be the maximum, before fatigue developed. Interpretation of continuous videotape records requires knowledge of speed over the bottom for results to be expressed quantitatively. Identification of fauna visible in video also requires thorough knowledge of species present. Initial investigation shows that groups or species which can be easily recognized when viewing Holme's videotapes include:

Echinoderms, including starfish, surface living brittle-stars (*Ophiothrix, Ophiocomina, Ophiura)*; *Echinus* and *Holothuria*.

Molluscs – the only species easily recognizable are scallops (*Pecten maximus*), queen scallops (*Aequipecten opercularis*) and whelks (*Buccinum undatum*).

Alcyonium digitatum

Eunicella verrucosa

Large anemones

Crabs and large hermit crabs

Hydroids and bryozoans attached to the sea-bed

Fish – dragonets (*Callionymus*), *Gadus* spp, occasional rays and flatfish, red band fish (*Cepola*) in holes

The video pictures are a useful aid in identifying bottom deposits and mapping boundaries between different grounds. It is possible to distinguish distribution and orientation of sand waves, ripple marks and other relief features, together with tubes and burrows of larger animals from video footage. These can then be classified into biotopes and the information entered into Marine Recorder.

4. It is possible to match videotape to 35mm film by using references in Holme's notebooks to the number of wheel revolutions. Most images (35mm) can be related to an reasonably exact location (latitude/longitude) by cross-referencing information in various logbooks for a particular tow, such as time, distance (m), wheel revolutions and Decca co-ordinates

5. Stills and video clips could be incorporated into a multimedia presentation, to demonstrate the range of level seabed types found along a part of the northern English Channel, in a similar manner to the Irish Sea Seabed Image Archive (ISSIA) (Allen & Rees, 1999). Interactive location maps could be produced to allow the user to interrogate video sledge tows and view images of the seabed there together with textual information describing physical characteristics (sea bed type) and biology (biotopes and species). More recent images taken during SCUBA diving of reef habitats in the same area as the towed sledge surveys could be added to the Holme images.

A web-link could be set-up attached to the *MarLIN* website. This would provide a GIS interactive map with all tows plotted and links to photographs, species, location, biotope, sediment type (i.e. fields in Marine Recorder). This would be a significant resource for research and education.

6. The material is in fairly urgent need of archiving and proper storage. It is recommended that for easy viewing and storage, the 35mm films are transferred to high quality CD. The reel-to-reel videotapes warrant transfer to at least video cassette format and then to DVD. The videocassettes should also be transferred to DVD. The original material should be stored at the Marine Biological Association Library in suitable climate controlled conditions.

7. The data should be entered into Marine Recorder to provide an English Channel archive, immediately as metadata on fauna, seabed types and biotopes.

10. ACKNOWLEDGEMENTS

Dan Lear for advice on latitude/longitude conversions and for developing initial mapping . For advice on archiving and digitisation: Geoff Laycock (HEDS, University of Hertfordshire), Elayne Hoskin and Jenny Day (South West Film and TV Archive), Ruth Kitchin (National Museum of Photography, Film and Television, Bradford), Tim Parmenter (Natural History Museum, London), Richard Edwards (Wildscreen, Bristol), The Video Ark (Ealing), and Systems Enterprises (Durham). For experimental scanning of 35mm film and transfer to CD: Mark Prior (Priority photo-processing, Plymouth) and Spectrum Photo Laboratories Ltd, Plymouth. Bob Barrett, ex technician on Holme's cruises, for useful comments on the report findings. Jessica Heard for help with manual conversion of Decca to latitude/longitude co-ordinates. Norman Revill (Skipper, Plymouth RV Plymouth Quest) for advice on Decca charts and conversion factors and loan of Decca charts not held by the library.

11. REFERENCES

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APPENDIX 1. Images available for each English Channel tow. Where no information is given, no records have been located.

Year	Month	Day	Tow	Film No. for seq-uence	Reel (No. in year)	Cass-ette No. for seq-uence	Location	Start Lat	Start Long	End Lat	End Long
1974	May	6					S. Fowey				
1974	May	30					Looe				
1974	June	20					Eddystone				
1975	April	23		1			S.Rame	50 15.59	4 12.23	50 14.55	4 12.19
1975	April	23		2			S Rame				
1975	April	24					St 14/Rame	50 15.33	4 15.48	50 15.37	4 16.21
1975	April	30		3			Plymouth 14	50 15.47	4 09.06	50 15.14	4 10. 08
1975	June	16		1			Plymouth = Allen 89	50 12.16	4 18.28	50 12.00	4 17.37
1975	June	16		2			Plymouth = Allen 42	50 11.65	4 19.90	50 11.90	4 19.70
1975	June	17		3			Allen 55	50 10.80	4 18.40		
1975	June	17		4			NW Eddystone	50 11.61	4 16.60	50 11.60	4 16.95
1975	June	17		6			W Eddystone	50 10.90	4 17.25	50 11.05	4 17.40
1975	June	17					W Eddystone	50 10.10	4 19.10	50 10.45	4 19.25
1975	June	18		7			Stevens 10 - Plymouth	50 16.35	4 7.80	50 16.80	4 7.60
1975	June	18		8			Stevens 3- Plymouth	50 15.85	4 4.80	50 15.60	4 5.30
1975	June	18					Plymouth	50 14.45	4 8.50	50 14.15	4 9.10
1976	May	4			2		Rame	50 16.80	4 12.30	50 15.75	4 12.30
1976	May				5		Rame Head				
1976	May	5			6		Plymouth	50 15.00	4 12.00		
1976	May	5			7		Plymouth	50 14.18	4 12.12		
1976	May	5			8		Plymouth	50 13.48	4 12.08		
1976	May	6		1			?				
1976	May	6		2			?				
1976	June	6			2		?				
1976	June	6			3		?				
1976	June	6			4		?				
1976	July	2		1			Plymouth	50 18.30	4 21.60	50 16.45	4 21.40
1976	July	2	1			1	Plymouth				
1976	June		2			1	Plymouth				
1976	July		3			1	Plymouth				
1976	July		4			1	Plymouth				
1976	July	3			5		Gribbin Head	50 17.60	4 41.90	50 17.20	4 42.40
1976	July	3			6		Gribbin Head	50 15.32	4 39.51	50 15.00	4 39.80
1976	July	3			7		Gribbin Head	50 15.08	4 39.43		
1976	July	3			8		Gribbin Head	50 14.04	4 39.30	50 12.95	4 39.20
1976	July	3			9		Gribbin Head	50 13.43	4 39.25		
1976	July	3	10			2	Gribbin Head				
1976	July	3	11			2	Gribbin Head				

Year	Month	Day	Tow	Film No. for seq-uence	Reel (No. in year)	Cass-ette No. for seq-uence	Location	Start Lat	Start Long	End Lat	End Long
1976	July	3	12			2	Gribbin Head				
1976	July	3		2			Gribbin Head				
1976	July	3		3			Gribbin Head				
1976	July	3		4			Gribbin Head				
1976	July	4			13	3					
1976	July	4			14	3					
1976	July	4			15	3					
1976	July	4			16	3					
1976	July	4			17	3	S. Polperro	50 14.34	4 39.37		
1976	July	4		5			S. Polperro	50 18.25	4 30.80	50 16.80	4 30.70
1976	July	4		6			S. Polperro	50 16.60	4 30.70	50 15.35	4 30.50
1976	July	5			18	3	S.Gribbin	50 14.90	4 30.50	50 12.05	4 29.90
1976	July	5			19		S.Gribbin	50 9.70	4 39.70	50 11.35	4 39.65
1976	July	5			20		S.Gribbin	50 10.40	4 39.60		
1976	July	5			21		S.Gribbin	50 11.30	4 39.70	50 13.05	4 39.10
1976	July	5			22		S.Gribbin	50 11.80	4 38.90		
1976	July	6			23		S.Dodman	50 12.40	4 39.10		
1976	July	6			24		S.Dodman	50 7.50	4 47.00	50 9.10	4 47.10
1976	July	6			25		S.Dodman	50 8.10	4 47.10	50 11.65	4 47.9
1976	July	6			28hd		S.Dodman	50 9.00	4 47.25		
1976	July	6		9			S.Dodman	50 10.95	4 47.90		
1976	July	?		7							
1976	July	?		8							
1976	July	6		10			Hand Deeps				
1976	July	7			29hd		Hand Deeps				
1976	July	7			30hd		Hand Deeps	50 17.70	4 30.90		
1976	July	7		11			Hand Deeps	50 16.20	4 30.65		
1976	July	8			31hd		S. Rame				
1976	July	8			32hd		S. Rame	50 13.35	4 12.05	50 13.60	4 12.25
1976	July	?		12			S. Rame	50 12.05	4 11.80		
1976	July	10			33hd		Dournenez Bay, Brittany				
1976	July	10			34hd		Dournenez Bay				
1976	July	10			35hd		Dournenez Bay				
1976	July	10		15			Dournenez Bay				
1976	July	11		16			Dournenez Bay				
1976	July	11		17			Dournenez Bay				
1976	July	11		18			Dournenez Bay				
1976	July	11		19			Dournenez Bay				
1977	May	17		1			Stoke Point	50 18.34	4 06.40	50 17.55	4 05.00

Year	Month	Day	Tow	Film No. for seq-uence	Reel (No. in year)	Cass-ette No. for seq-uence	Location	Start Lat	Start Long	End Lat	End Long
1977	May	17		3			Stoke Point	50 17.45	4 4.45	50 16.90	4 3.15
1977	May	18		4			Bigbury	50 15.22	3 57.55	50 15.70	3 55.90
1977	May	18		5			Bigbury	50 16.41	3 56.59	50 15.24	3 56.53
1977	May	18		6			Bigbury	50 15.11	3 56.53	50 14.37	3 56.54
1977	May	19		8 to 9			S.Rame	50 16.40	4 12.30	50 13.12	4 12.45
1977	May	19		9 to 12			S Rame	50 15.85	4 12.40	50 17.08	4 12.20
1977	May	19		12to 13			S Rame	50 15.75	4 12.30	50 17.1	4 12.23
1977	May	21			21		Rame	50 13.92	4 3.59	50 15.7	4 3.50
1977	May	21		7			Bigbury				
1977	May	21		8			Outside Spoil Ground	50 15.94	4 12.41	50 16.20	4 13.80
1977	May	23			23		Outside Spoil Ground	50 15.53	3 58.18	50 16.26	3 56.14
1977	May	23			24		Outside Spoil Ground	50 10.38	4 01.47	50 11.55	4 02.20
1977	May	23			25		Outside Spoil Ground	50 12.02	4 02.15	50 13.50	4 02.46
1977	May	23			26		Outer Part C375				
1977	May	23			27		Outer Part C375	50 13.50	4 02.46		
1977	May	23			28		C375 and Gerrans Bay	50 13.03	4 11.59	50 11.06	4 11.37
1977	May	24			29		Gerrans Bay	50 13.03	4 12.00		
1977	May	24			30		Gerran				
1977	May	24			31		Gerran	50 10.12	4 55.39	50 9.90	4 55.30
1977	May	24		9			Gerran	50 06.39	4 54.32	50 05.33	4 56.05
1977	May	24		10			Gerran	50 05.33	4 56.11		
1978	June	28					Looe Ground	50 14.43	4 26.46	50 14.57	4 27.54
1978	June	29			2		Gerrans Bay	50 04.49	4 54.38		
1978	June	30			3		Gerran	50 03.00	4 53.57		
1978	June	30			4		Gerran	50 00.02	4 53.03	50 01.43	4 53.30
1978	June	30			5		S.Coverack	49 59.39	5 03.17	49 57.56	5 02.36
1978	June	30			6		Off Berry Head	50 15.20	3 22.34	50 14.30	3 24.58
1978	June	30			7		Off Dartmouth	50 14.30	3 23.10	50 15.13	3 24.11
1978	June	30			8		Gerran				
1978	June	30			9		Gerran				
1978	June	30		2			Gerran				
1978	June	30		3			Gerran				
1978	July	30		4			Gerran				
1978	July	1			10		Coverak	49 59.70	5 03.20	50 14.57	3 38.28
1978	July	1			11		Coverak				
1978	July	1			12		Coverak				
1978	July	3			13		Berry Head				

Year	Month	Day	Tow	Film No. for seq-uence	Reel (No. in year)	Cass-ette No. for seq-uence	Location	Start Lat	Start Long	End Lat	End Long
1978	July	3			14		Berry Head				
1978	July	3			15		Berry Head				
1978	July	7		6			?				
		7		7			?				
1979	June	19			1		Start Bay				
1980	June	6		6			?				
1980	June	24			5		Looe Ground	50 14.51	4 26.33	50 14.57	4 27.11
1980	June	25			6		Looe Ground	50 14.53	4 26.36	50 13.46	4 18.58
1980	June	25			7		Eddystone				
1980	June	25		2			Eddystone				
1980	June	25		3			Eddystone Allen 42				
1980	June	26			8		Looe Brittle Star Ground	50 15.39	4 30.52		
1980	June	26			9		Looe Repeat				
1980	June	26			10		Looe Repeat				
1980	June	26			11		Looe Repeat				
1980	June	26		4			Looe Repeat				
1980	June	26		5			Looe Repeat				
1980	July	2	2				Sleepy Valley/Eddystone	50 10.25	4 01.41	50 11.20	4 01.47
1980	July	3					S Lizard	49 36.44	5 12.08	49 38.58	5 11.39
1980	July	4			16		E Lizard	49 55.23	4 33.09	49 55.22	4 33.31
1981	August	11					Mevagissey				
1981	August	12	2								
1981	August	12	3	3			Dodman	50 10.51	4 47.56	50 09.33	4 47.37
1981	August	12	3	3			Dodman	50 09.06	4 47.34	50 07.53	4 47.09
1981	August	12	4				S.Gribbin	50 15.30	4 39.45	50 15.13	4 39.40
1981	August	12	5				S Gribbin				
1981	Sept	11	1				Torbay	50 26.06	3 28.53		
1981	Sept	12	2				GreatWestern Bay	50 11.14	2 57.53	50 11.44	2 53.47
1981	Sept	12	3	3			GreatWestern Bay	50 14.02	2 29.56	50 14.52	2 26.57
1981	Sept	12	4	4			S of Portland	50 14.43	2 18.48	50 14.41	2 18.53
1981	Sept	13					S Portland				
1981	Sept	15	5	5			GreatWestern Bay				
1981	Sept	15	6	6			GreatWestern Bay				
1981	Sept	15				8					

Year	Month	Day	Tow	Film No. for seq-uence	Reel (No. in year)	Cass-ette No. for seq-uence	Location	Start Lat	Start Long	End Lat	End Long
1981	Sept	16	7				S Portland	50 18.44	2 29.32	50 13.31	2 36.08
1981	Sept	16	8				S.Portland				
		16	9				S.Portland				
1982	May	15					S.Portland	50 22.00	2 24.23	50 22.12	2 21.33
1982	May	16	8			10	S.Portland				
1982	May	16	8	8		10, 11	S.Anvil Point	50 26.15	1 39.40	50 27.40	4 33.58
1982	May	5		5			?				
1982	May	13	1			1	Freshwater Bay				
1982	May	14	2	2		2, 3	S Portland				
1982	May	14	3	3		4, 5	S.Portland				
1982	May	15	4	4		6, 72	S Portland				
1982	May	16	6	6		8, 9	S.Anvil Point				
1982	May	16	8	8		10, 11	S.Anvil Point				
1982	May	17	9	9		12	Dodman	50 10.25	4 39.36	50 11.23	4 44.07
1982	May	17	10	10		13	Dodman	50 01.32	4 35.30	50 01.45	3 39.57
1982	May	17	11	11		14	Dodman	50 01.44	4 45.27	50 01.46	3 42.55
1982	May	19	12	12		15	Start Point	49 49.06	3 39.01	49 47.46	3 45.47
1982	May	19	13	15		16	S Eddystone	50 05.04	3 43.42	50 04.52	4 07.40
1982	May	20	14	16		17	S Eddystone	49 55.56	3 47.48	49 57.15	4 04.46
1982	May	20	15			18	S Eddystone	49 51.02	4 06.06	49 51.35	
		20	16			20	S Eddystone	49 49.25	4 07.19	49 49.16	
1984	May	?		1		1	?				
1984	May	5		2			GreatWestern Bay	50 10.18	3 18.43	59 11.08	1 12.40
1984	May	6		3		2	Isle of Wight	50 28.30	1 00.00	50 27.50	
1984	May	6		4		2	Isle of Wight	50 28.80	1 14.70	50 28.50	1 12.60
1984	May	7		5		3	Isle of Wight				1 17.30
1984	May	8		6		4	Isle of Wight	50 27.00	1 13.20	50 27.20	
1984	May	9	9	7		5	Isle of Wight	50 24.10	1 15.80	50 23.50	1 54.20
1984	May	9	10	8		7	Isle of Wight				1 37.80
1984	May	10		9		8	S Anvil Point	50 17.50	1 57.30	50 19.35	4 46.35
1984	May	10		10		9	S Anvil Point	50 27.30	1 37.00	50 28.20	
1984	May	12		11		10	Dodman	50 07.35	4 46.44	50 10.15	
1984	May	12		12		11	Dodman				4 41.29
1984	May	12		13		12	Gribbin				4 37.19
1984	May	13		14		13	Mid Channel	49 36.15	4 41.19	49 39.05	4 12.50
1984	May	13		15		14	Mid Channel	49 40.37	4 39.22	49 38.17	4 19.18

Year	Month	Day	Tow	Film No. for seq-uence	Reel (No. in year)	Cass-ette No. for seq-uence	Location	Start Lat	Start Long	End Lat	End Long
1984	May	14		16		15	Rame Head	50 08.40	4 46.27	50 15.34	4 76.90
1984	May	17				16	W. Eddystone	50 11.03	4 19.51	50 11.05	4 42.33
1984	May	18				17	Looe Ground	50 17.20	4 35.70	50 15.55	4 38.30
1984	May			19			Pisces Ground	50 16.10	4 43.00	50 17.05	
1984	May	20		20		18	S.Gribbin	50 11.06	4 38.59	50 09.27	
1984	August	20				18	S.Gribbin				
		21		1			?				
1985	June	18		1			?				
1986	June	2		1			?				
1986	June	3		2			?				
1986	June	4		3			?				
		4		4			?				

APPENDIX 2. Catalogue of coverage of main TV sled tows between 1975 and 1984.

Year	Month	Day	Location	Decca start red	Decca start green	Decca start purple	Decca end red	Decca end green	Decca end purple	Latitude start	Longitude start	Latitude end	Longitude end
1975	April	23	S.Rame Head					C37.57		50 15.59	4 12.23	50 14.55	4 12.19
1975	April	24	St 14/Rame					C45.40		50 15.33	4 15.48	50 15.37	4 16.21
1975	April	30	Plymouth 14					C33.18		50 15.47	4 09.06	50 15.14	4 10. 08
1975	June	16	Plymouth = Allen 89					D31.17		50 12.16	4 18.28	50 12.00	4 17.37
1975	June	16	Plymouth = Allen 42					D35.58	A77.22	50 11.65	4 19.90	50 11.90	4 19.70
1975	June	17	Allen 55							50 10.80	4 18.40		
1975	June	17	NW Eddystone					C47.92		50 11.61	4 16.60	50 11.60	4 16.95
1975	June	17	W Eddystone					D31.13		50 10.90	4 17.25	50 11.05	4 17.40
1975	June	17	W Eddystone					D34.71		50 10.10	4 19.10	50 10.45	4 19.25
1975	June	18	Steven 10 = Plymouth					B46.35		50 16.35	4 7.80	50 16.80	4 7.60
1975	June	18	Steven 3 = Plymouth					B41.85		50 15.85	4 4.80	50 15.60	4 5.30
1975	June	18	Plymouth					C31.46		50 14.45	4 8.50	50 14.15	4 9.10
1976	May	4	Rame					C37.48		50 16.80	4 12.30	50 15.75	4 12.30
1976	May	5	Plymouth							50 15.00	4 12.00		
1976	May	5	Plymouth							50 14.18	4 12.12		
1976	May	5	Plymouth							50 13.48	4 12.08		
1976	July	2	Plymouth					D37.40	B58.56	50 18.30	4 21.60	50 16.45	4 21.40
1976	July	3	Gribbin Head					F42.20	B77.92	50 17.60	4 41.90	50 17.20	4 42.40
1976	July	3	Gribbin Head					F37.98	B71.00	50 15.32	4 39.51	50 15.00	4 39.80
1976	July	3	Gribbin Head							50 15.08	4 39.43		
1976	July	3	Gribbin Head					F37.50	B65.80	50 14.04	4 39.30	50 12.95	4 39.20
1976	July	3	Gribbin Head							50 13.43	4 39.25		
1976	July	4	S. Polperro							50 14.34	4 39.37		
1976	July	4	S. Polperro	A6.20	E37.48	B71.12	A7.34	E37.52	B67.90	50 18.25	4 30.80	50 16.80	4 30.70
1976	July	4	S. Polperro	A7.48	E37.48	B67.48	A8.56	E37.64	B64.40	50 16.60	4 30.70	50 15.35	4 30.50
1976	July	4	S. Polperro	A9.00	E37.70	B63.44	A12.14	E37.75	B56.9	50 14.90	4 30.50	50 12.05	4 29.90
1976	July	5	S.Gribbin	A16.46	E37.76	B60.64	A14.68	F37.46	B62.10	50 9.70	4 39.70	50 11.35	4 39.65
1976	July	5	S.Gribbin	15.54	F37.68	62.44				50 10.40	4 39.60		
1976	July	5	S.Gribbin	14.5	F37.5	63.5	A12.68	F37.5	B65.0	50 11.30	4 39.70	50 13.05	4 39.10
1976	July	5	S.Gribbin	13.96	F37.52	64.9				50 11.80	4 38.90		
1976	July	5	S.Gribbin	13.22	F37.52	61.46				50 12.40	4 39.10		

1976	July	6	S.Dodman	20.38	G37.7	62.56	A18.24	G37.42	B64.80	50 7.50	4 47.00	50 9.10	4 47.10
1976	July	6	S.Dodman	A19.58	G37.6	64.46	A15.76	G37.62	B69.34	50 8.10	4 47.10	50 11.65	4 47.9
1976	July	6	S.Dodman	18.48	G37.44	64.46				50 9.00	4 47.25		
1976	July	6	S.Dodman	16.32	G37.66	68.34				50 10.95	4 47.90		
1976	July	7	Hand Deeps	A6.2	D37.4	B57.77				50 17.70	4 30.90		
1976	July	7	Hand Deeps	A7.8	D37.6	B53.78				50 16.20	4 30.65		
1976	July	8	S. Rame	A6.84	C37.66	A72.82	A6.52	C37.95	B50.52	50 13.35	4 12.05	50 13.60	4 12.25
1976	July	8	S. Rame	A8.44	C37.48	A69.84				50 12.05	4 11.80		
1977	May	17	Stoke Point	A0.9	B44.53		A0.9	B41.2	A77.55	50 18.34	4 06.40	50 17.55	4 05.00
1977	May	17	Stoke Point	A1.1	B40.2	A75.15	A1.28	B37.65	A71.8	50 17.45	4 4.45	50 16.90	4 3.15
1977	May	18	Bigbury	A0.9	A45.1	63.9A	A0.3	A43.7	62.3A	50 15.22	3 57.55	50 15.70	3 55.90
1977	May	18	Bigbury	A0.1	A43.75	63.9A	A0.63	A43.1	A61.35	50 16.41	3 56.59	50 15.24	3 56.53
1977	May	18	Bigbury	A0.78	A43.06	60.70A	A1.28	A43.08	59..27	50 15.11	3 56.53	50 14.37	3 56.54
1977	May	19	S.Rame Head	A3.3	C37.5	B51.5	A4.57	C39.67	A72.22	50 16.40	4 12.30	50 13.12	4 12.45
1977	May	19	S Rame	A4.62	C37.52		A7.06	C37.52		50 15.85	4 12.40	50 17.08	4 12.20
1977	May	19	S Rame	A4.17	C37.44	A79.97	A3.0	C37.36	52.7	50 15.75	4 12.30	50 17.1	4 12.23
1977	May	20	Stoke Point	A3.96	B38.64	65.11	2.01	38.13	70	50 13.92	4 3.59	50 15.7	4 3.50
1977	May	21	Rame	A4.00	C37.50	A79.30	4.25	40.38	50.95	50 15.94	4 12.41	50 16.20	4 13.80
1977	May	21	Bigbury	0.65A	45.92A	A64.05	0.08	42.24	62.71	50 15.53	3 58.18	50 16.26	3 56.14
1977	May	21	Outside Spoil Ground	A9.07	B36.9	A57.15	6.7	37	59.72	50 10.38	4 01.47	50 11.55	4 02.20
1977	May	23	Outside Spoil Ground	A6.48	B36.74	A59.85	3.85	36.9	64.13	50 12.02	4 02.15	50 13.50	4 02.46
1977	May	23	Outside Spoil Ground	A3.85	B36.9					50 13.50	4 02.46		
1977	May	23	Outer Part C375	A7.22	C37.51	A72.05	10	37.77	67.8	50 13.03	4 11.59	50 11.06	4 11.37
1977	May	23	Outer Part C375	A7.22	C37.51					50 13.03	4 12.00		
1977	May	24	Gerrans Bay	A18.31	H34.91		18.47	34.92	71.47	50 10.12	4 55.39	50 9.90	4 55.30
1977	May	24	Gerran	A22.28	H35.15	B65.21	A23.8	H38.85	B64.87	50 06.39	4 54.32	50 05.33	4 56.05
1977	May	24	Gerran	A23.8	H39.05					50 05.33	4 56.11		
1978	June	28	Looe Ground	A8.52	E30.22	B59.72	A8.52	E32.38	B61.22	50 14.43	4 26.46	50 14.57	4 27.54
1978	June	29	Gerans Bay	B0.62	H36.4	B62.28	B3.12	H36.4	B59.08	50 04.49	4 54.38		
1978	June	30	Gerran	B2.98	H36.14	B59.15	B5.57	H36.08	B56.20	50 03.00	4 53.57		
1978	June	30	Gerran	B7.14	H36.22	B54.53	B4.74	H36.06	B57.00	50 00.02	4 53.03	50 01.43	4 53.30
1978	June	30	S.Coverack	B7.87	I38.52	B60.50	B10.2	I38.18		49 59.39	5 03.17	49 57.56	5 02.36
1978	June	30	Off Berry Head	C13.36	A30.1	C60.17	C9.28	A30.2	C60.28	50 15.20	3 22.34	50 14.30	3 24.58
1978	June	30	Off Dartmouth	C13.26	A30.22	B71.8	C9.95	A30.1	72	50 14.30	3 23.10	50 15.13	3 24.11
1978	July	1	Coverak	B7.87	I38.52		B10.2	I38.18	I38.18	49 59.70	5 03.20	50 14.57	3 38.28

1979	June	19	Start Bay	B13.9	J47.9	B62.6	B13.56		B61.65	50 16.65	3 32.35	50 16.35	3 32.55
1979	June	19	Start Bay	B20.4		B57.24	B19.11		B54.80	50 14.05	3 31.00	50 13.60	3 31.80
1979	June	19	off Berry Head	B15.52		C75.9	C2.63		C75.7	50 26.25	3 28.51	50 24.31	3 23.20
1979	June	20	E Start Point	B16.10		B54.43	B15.60		54.15	50 21.29	3 29.35		
1980	June	24	Looe Ground	A8.34	D47.76	B59.99	A8.37	E30.97	B60.72	50 14.51	4 26.33	50 14.57	4 27.11
1980	June	24	Looe Ground	A8.65	D45.8	B57.84	A8.39	D47.50	B59.65	50 14.21	4 25.29	50 14.47	4 26.24
1980	June	24	Looe Ground	A8.31	D47.83	B59.98	A7.92	E33.11	B63.03	50 14.53	4 26.36	50 13.46	4 18.58
1980	June	25	Looe Ground	A8.12	E33.76	B63.23	A7.94	E38.24	B66.90	50 15.30	4 28.41	50 16.11	4 31.04
1980	June	25	Eddystone	A9.91	D31.55	A75.76	A9.57	D32.62	A77.06	50 12.00	4 17.49	50 12.21	4 18.26
1980	June	25	Eddystone	A11.23	D32.86	A74.35	A11.8	D32.5	A73.26	50 11.08	4 18.15	50 10.42	4 17.57
1980	June	25	Eddystone Allen 42	A10.50	D35.83	A77.49	A12.60	D34.06	A73.15	50 11.53	4 19.57	50 10.15	4 18.37
1980	June	26	Looe Brittle Star Ground		E38	B66				50 15.39	4 30.52		
1980	July	2	Sleepy Valley/Edstne		B34.5	A55.4		B34.31	A56.98	50 10.09	4 00.15	50 10.32	4 00.22
1980	July	2	Sleepy Valley/Edstne		B36.91	A57.13	A7.26	B36.32	A58.58	50 10.25	4 01.41	50 11.20	4 01.47
1980	July	3	S Lizard	C16.8	J47.4	A73.45	C13.48	J45.92	A74.87	49 36.44	5 12.08	49 38.58	5 11.39
1980	July	4	E Lizard	B15.9	F37.5	A66.2	B15.9	F38.2	A66.3	49 55.23	4 33.09	49 55.22	4 33.31
1981	Augus t	11	Mevagissey Bay				A11.5	F45.0	B73.1			50 14.53	4 43.26
1981	Augus t	12	Dodman	A16.5	G37.78	B68.04	A17.97	G37.82		50 10.51	4 47.56	50 09.33	4 47.37
1981	Augus t	12	Dodman	A18.5	G37.98	B64.8	A19.96	G37.82		50 09.06	4 47.34	50 07.53	4 47.09
1981	Augus t	12	S.Gribbin Head	A10.25	F37.53	B71.7	A10.52	F37.48		50 15.30	4 39.45	50 15.13	4 39.40
1981	Augus t	12	S Gribbin	A11.6	F37.52	B68.5	A12.7	F37.55		50 14.06	4 39.28	50 13.02	4 39.15
1981	Sept	11	Torbay	B15.52	A33.65	C74.48	B15.66	A33.65	74.88	50 26.06	3 28.53		
1981	Sept	12	GreatWestern Bay	F0.80	A31.1	C72.04	F8.05		C78.54	50 11.14	2 57.53	50 11.44	2 53.47
1981	Sept	12	GreatWestern Bay	G23.4		E50.71	H2.68		E55.54	50 14.02	2 29.56	50 14.52	2 26.57
1981	Sept	12	S of Portland	H15.9		E62.51	H15.84		E62.34	50 14.43	2 18.48	50 14.41	2 18.53
1981	Sept	15	GreatWestern Bay	E10.8		C62.1	E5.74		C56.04	50 11.04	3 04.50	50 10.20	3 07.54
1981	Sept	15	GreatWestern Bay	F16.52		D55.78	F21.9		D60.2	50 12.15	2 48.56	50 12.33	2 45.49
1981	Sept	16	S Portland	H16.4		E62.64	H16.18		E62.35	50 14.41	2 18.32	50 14.38	2 18.44
1981	Sept	16	S.Portland	H11.28		E62.65	H13.13		E60.64	50 15.31	2 20.45	50 14.38	2 20.43
1981	Sept	16	S.Portland	G14.04		E62.66	G13.72		D73.25	50 18.44	2 29.32	50 13.31	2 36.08
1982	May	13	Freshwater Bay	I12.22		G70.67	I6.48		G73.58	50 33.40	1 33.95	50 35.05	1 35.40
1982	May	14	S Portland	H14.14		E63.32	H12.92		E63.04	50 15.15	2 19.15	50 15.22	2 19.53
1982	May	14	S.Portland	H17.96		E71.93	H16.75		E76.41	50 17.09	2 14.08	50 18.40	2 12.54

1982	May	15	S Portland	H5.97		E52.92	1.28		57.5	50 13.35	2 26.33	50 15.39	2 26.51
1982	May	15	S Portland	G17.30		D75.62	21.34		78.42	50 22.00	2 24.23	50 22.12	2 21.33
1982	May	16	S.Anvil Point	I14.60		F56.46	I16.0		F60.38	50 28.20	1 40.90	50 29.40	1 37.60
1982	May	16	S.Anvil Point	I19.48		F52.90	I19.49		F56.71	50 26.15	1 39.40	50 27.40	1 37.00
1982	May	17	Dodman	A15.80	F40.49	B61.79	14.33	36.06	62.12	50 10.25	4 39.36	50 11.23	4 37.37
1982	May	17	Dodman	B4.5	F37.82	A74.61	4.09	33.25	73.75	50 01.32	4 35.30	50 01.45	4 33.58
1982	May	18	Gerrans	B4.4	G38.26	B51.68	B4.31	G35.61	B50.75	50 01.44	4 45.27	50 01.46	4 44.07
1982	May	18	Start Point	E0.18	B42.82	A56.60	E2.71	B45.34	A55.93	49 49.06	3 39.01	49 47.46	3 39.57
1982	May	19	Prawle Point	B15.10	A40.56	A54.92	B17.04	A40.44	A55.70	50 05.04	3 43.42	50 04.52	3 42.55
1982	May	19	Prawle Point	C14.54	B40.02	A51.78	C13.05	B36.24	A52.80	49 55.56	3 47.48	49 57.15	3 45.47
1982	May	19	S Eddystone	C11.95	D33.11	A50.64	C9.43	34.66	51	49 51.02	4 06.06	49 51.35	4 07.40
1982	May	20	S Eddystone	C15.56	D36.96	A50.72	C17.85	D33.61	A50.25	49 49.25	4 07.19	49 49.16	4 04.46
1984	May	5	Great Western Bay	D6.42	A31.59	B69.55	D5.82	A31.24	B72.20	50 10.18	3 18.43	59 11.08	3 18.16
1984	May	6	Isle of Wight	A0.00		G70.60	A1.08		G69.84	50 28.30	1 00.00	50 27.50	0 59.60
1984	May	6	Isle of Wight	J12.90		G67.40	J15.15		G67.35	50 28.80	1 14.70	50 28.50	1 12.40
1984	May	7	Isle of Wight	J16.23		G66.57	J16.57		G64.77	50 27.90	1 12.00	50 27.20	1 13.40
1984	May	8	Isle of Wight	J16.98		G64.33	J16.59		G64.93	50 27.00	1 13.20	50 27.20	1 12.60
1984	May	9	Isle of Wight	J19.98		G58.20	J19.89		G56.55	50 24.10	1 15.80	50 23.50	1 17.30
1984	May	9	Isle of Wight	A01.10		G60.11	J22.11		G61.32	50 24.00	1 90.00	50 25.10	1 13.40
1984	May	10	S Anvil Point	I15.67		F54.26	I15.50		F60.47	50 17.50	1 57.30	50 19.35	1 54.20
1984	May	10	S Anvil Point	I19.57		F56.68	I17.41		F58.00	50 27.30	1 37.00	50 28.20	1 37.80
1984	May	12	Dodman	A20.10	G37.20	B61.79	A17.00		B66.64	50 07.35	4 46.44	50 10.15	4 46.35
1984	May	12	Dodman	A16.67	G36.40	B67.19	A15.46	G35.65	B69.03	50 10.25	4 47.07	50 11.27	4 47.00
1984	May	12	Gribbin	A12.80	F37.31	B65.79	A15.07	F38.5	B62.46	50 12.55	4 39.05	50 10.58	4 39.14
1984	May	13	Mid Channel	D3.76	H31.08	A58.92	C22.09	G47.36	A60.28	49 36.15	4 41.19	49 39.05	4 41.29
1984	May	13	Mid Channel	C19.81	G42.66	A60.00	D01.44		A58.39	49 40.37	4 39.22	49 38.17	4 37.19
1984	May	14	Rame	A05.18	G37.83	A77.12	A4.34	C38.48	A79.67	50 08.40	4 46.27	50 15.34	4 12.50
1984	May	17	W. Eddystone	A11.48	D36.11	A76.07	A11.31	D35.00	A75.60	50 11.03	4 19.51	50 11.05	4 19.18
1984	May	18	Looe Ground	A7.90	E47.29	B60.83	A7.96	E32.20	B62.77	50 17.20	4 35.70	50 15.55	4 76.90
1984	May		Pisces Ground	A10.08	F43.66	B76.24	A9.13	F42.44	B78.01	50 16.10	4 43.00	50 17.05	4 42.33
1984	May	20	S.Gribbin	A14.76	F37.98	B62.52	A16.69	F37.88	B58.99	50 11.06	4 38.59	50 09.27	4 38.30
1984	Augus t	21	Looe Ground	A8.51	E33.66	B62.52				50 15.00	4 28.33		

APPENDIX 3. Details of two selected tows from 1977 to illustrate position and depth every five minutes**.**

The information below has been used to produce the map in Figure 3.

DATE	TIME	Decca co-ordinates			Depth (m)	LAT. N	LONG. W
		Red	Green	Purple			
17/5/77	off Mewstone, Stoke Point						
TOW A	13:30	A1.05	B43.55		34	50 18.05	4 06.13
TOW A	13:37	1.00	43.50		34	50 18.10	4 06.11
TOW A	13:42	1.05	43.52		34	50 18.04	4 06.12
TOW A	13:50	1.06	43.40		35	50 18.02	4 06.08
TOW A	13:55	1.04	43.40		35	50 18.04	4 06.08
TOW A	14:00	1.04	43.30		31	50 18.03	4 06.05
TOW A	14:05	1.01	43.15		30	50 18.03	4 06.00
TOW A	14:10	1.02	43.09		35	50 18.03	4 05.58
TOW A	14:15	1.00	43.00	A78.9	35	50 18.04	4 05.55
TOW A	14:20	1.00	42.90	78.90	35	50 18.03	4 05.52
TOW A	14:30	1.00	42.65	78.70		50 18.00	4 05.45
TOW A	14:35	1.00	42.50	78.60	31	50 17.59	4 05.40
TOW A	14:40	0.97	42.45	78.47	36	50 18.01	4 05.38
TOW A	14:45	1.00	42.30	78.30	36	50 17.56	4 05.34
TOW A	14:50	1.00	42.10	78.00	35	50 17.54	4 05.28
TOW A	14:55	1.00	42.00	77.85	35	50 17.53	4 05.25
TOW A	15:00	1.00	41.80	77.80		50 17.51	4 05.19
TOW A	15:05	0.95	41.65	77.60	37	50 17.55	4 05.14
TOW A	15:10	0.95	41.50	77.65		50 17.53	4 05.09
TOW A	15:15	0.92	42.00	77.70		50 18.02	4 05.24
TOW A	15:20	0.92	41.80	77.65		50 18.00	4 05.18
TOW A	15:25	0.92	42.50			50 18.08	4 05.39
TOW A	15:30	0.90	41.20	77.55	37	50 17.55	4 05.00
TOW A	17:10	1.10	40.20	75.15		50 17.22	4 04.32
TOW A	17:15	1.12	40.10	74.90	42	50 17.19	4 04.29
TOW A	17:20	1.16	40.00	74.70	43	50 17.14	4 04.26
TOW A	17:25	1.20	39.90	74.50	42	50 17.09	4 04.24
TOW A	17:30	1.22	39.70	74.20	43	50 17.05	4 04.18
TOW A	17:35	1.28	39.60	74.02	42	50 16.59	4 04.15
TOW A	17:40	1.11	39.26	73.94	43	50 17.11	4 04.03
TOW A	17:45	1.13	39.18	73.79	43	50 17.08	4 04.01
TOW A	17:50	1.14	39.15	73.74	43	50 17.07	4 04.00
TOW A	17:55	1.30	39.25	73.55	44	50 16.53	4 04.05
TOW A	18:00	1.25	39.10	73.50	43	50 16.56	4 04.00
TOW A	18:05	1.25	38.90	73.25	43	50 16.54	4 03.54
TOW A	18:10	1.25	38.70	73.10	43	50 16.52	4 03.48
TOW A	18:15	1.25	38.40	72.90	43	50 16.49	4 03.39
TOW A	18:23	1.25	38.20	72.60	43	50 16.47	4 03.33
TOW A	18:25	1.25	38.00	72.25	43	50 16.45	4 03.26
TOW A	18:35	1.28	37.65	71.80		50 16.38	4 03.16
TOW A	18:40	END TOW					
TOW B	19/05/1977	South of Rame Head					
TOW B	09:35	A3.3	C37.5	B51.5	50	50 14.22	4 03.09
TOW B	09:40	3.40	37.52	51.28	51	50 14.17	4 03.09
TOW B	09:45	3.49	37.52	51.06	51	50 14.13	4 03.08
TOW B	09:50	3.58	37.52	A50.77	51	50 14.08	4 03.07
TOW B	09:55	3.75	37.53	A50.37	51	50 13.59	4 03.06
TOW B	10:05	3.81	37.58	50.17	51	50 13.57	4 03.08
TOW B	10:11	3.88	37.61	B50.0	51	50 13.54	4 03.08

DATE	TIME	Decca co-ordinates			Depth (m)	LAT. N	LONG. W
		Red	Green	Purple			
TOW B	10:15	3.93	37.64	A79.79	52	50 13.51	4 03.09
TOW B	10:20	4.00	37.68	A79.62	52	50 13.48	4 03.09
TOW B	10:25	4.05	37.70	A79.48	52	50 13.46	4 03.09
TOW B	10:30	4.13	37.73	79.30	52	50 13.43	4 03.10
TOW B	10:35	4.18	37.76	79.18	52	50 13.40	4 03.10
TOW B	10:40	4.23	37.78	79.10	52	50 13.38	4 03.11
TOW B	10:45	4.26	37.64	79.10	52	50 13.36	4 03.06
TOW B	10:50	4.33	37.67	78.85	52	50 13.33	4 03.06
TOW B	10:55	4.42	37.70	78.70	52	40 13.29	4 03.06
TOW B	11:00	4.47	37.65	78.59	52	50 13.26	4 03.04
TOW B	11:05	4.54	37.62	78.22	52	50 13.23	4 03.03
TOW B	11:08	4.57	37.67	78.16	52	50 13.22	4 03.04
TOW B	11:44	4.62	37.52	A77.9	51	50 13.19	4 02.59
TOW B	11:50	4.71	37.63	77.77	52	50 13.16	4 03.02
TOW B	11:55	4.77	37.72	77.69	52	50 13.14	4 03.04
TOW B	12:00	4.80	37.76	77.63	52	50 13.13	4 03.05
TOW B	12:05	4.83	31.74	77.54	52	50 12.40	3 59.54
TOW B	12:10	4.84	37.70	77.45	52	50 13.10	4 03.03
TOW B	12:12	4.87	37.65	77.30	50	50 13.09	4 03.01
TOW B	12:20	4.94	37.60	77.08		50 13.06	4 02.58
TOW B	12:30	4.98	37.53	77.93		50 13.04	4 02.56
TOW B	12:35	5.02	37.60	76.81	51	50 13.02	4 02.58
TOW B	12:40	5.11	37.81	76.71	51	50 13.00	4 03.03
TOW B	12:45	5.20	38.00	76.70	51	50 12.57	4 03.09
TOW B	12:50	5.26	37.93	76.57	51	50 12.54	4 03.06
TOW B	12:55	5.27	37.86	76.41	51	50 12.53	4 03.03
TOW B	13:00	5.35	37.86	76.20	50	50 12.50	4 03.03
TOW B	13:05	5.46	37.91	76.04	51	50 12.46	4 03.03
TOW B	13:10	5.50	37.84	75.91	51	50 12.44	4 03.00
TOW B	13:14	5.57	37.80	75.70		50 12.41	4 02.58
TOW B	13:20	5.66	37.78	75.53	51	50 12.37	4 02.57
TOW B	13:25	5.73	37.67	75.27	52	50 12.34	4 02.53
TOW B	13:30	5.77	37.58	75.14	51	50 12.32	4 02.49
TOW B	13:35	5.82	37.55	75.00	51	50 12.30	4 02.48
TOW B	13:40	5.96	37.67	74.71	51	50 12.25	4 02.50
TOW B	13:45	6.04	37.61	74.55	52	50 12.22	4 02.47
TOW B	13:50	6.09	37.51	74.31	51	50 12.19	4 02.44
TOW B	13:55	6.14	37.46	74.15	52	50 12.17	4 02.42
TOW B	14:00	6.22	37.55	73.96	53	50 12.15	4 02.43
TOW B	14:05	6.36	37.55	73.72	53	50 12.09	4 02.42
TOW B	14:10	6.46	37.55	73.56	53	50 12.06	4 02.41
TOW B	14:15	6.54	37.53	73.38	53	50 12.03	4 02.39
TOW B	14:20	6.63	37.53	73.18	53	50 12.00	4 02.38
TOW B	14:25	6.70	37.53	73.05	54	50 11.57	4 02.37
TOW B	14:30	6.79	37.51	78.83	54	50 11.54	4 02.36
TOW B	14:35	6.89	37.52	72.64	54	50 11.50	4 02.35
TOW B	14:40	6.96	37.40	72.50		50 11.47	4 02.30
TOW B	14:45	7.05	37.52	72.22		50 11.45	4 02.33
TOW B	END TOW						

APPENDIX 4. Contact details for archiving.

National Museum of Photography, Film and Television, Bradford – www nmpft.org
Tel 0870 7010200. E-mail talk.nmpft@nmsi.ac.uk.

TSW Film and TV Archive, Melville Building, Royal William Yard, Stonehouse, Plymouth
Tel. 01752 202650 Director: Elayne Hoskin. E-mail elayne@tswfta.co.uk.

Higher Education Digitisation Services, University of Hertfordshire. Geoff Laycock Tel. 01707 286078. E-mail: g.laycock@herts.ac.uk.

Natural History Museum, London – Tim Parmenter. Tel. 0207 9425839 (Natural History Museum Image Resources and Photography Tel 0207942 5401/5323)

Wildscreen, Bristol – Tel 0117 91157217. Richard Edwards.

Spectrum Photographic Laboratories,6 Stonehouse Street, Plymouth PL1 3PE. Tel. 01752 202929. E-mail: support@spectrumphotolabs.co.uk. www.spectrumphotolabs.co.uk.