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Development of methods for monitoring subtidal biotope extent using remote video: A Report for the UK Marine SACs Project

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[1] Since this report was written SeaMap have changed their name to Envision Mapping. For the purpose of this report they will continue to be referred to as SeaMap.

Summary

This report describes an assessment of the use of remote video, collected by ROV, towed sledge or drop-down video methods, to monitor seabed biotope extent in a marine SAC. Data and video footage for the assessment were taken from the results of ROV trials carried out in the Sound of Arisaig in February 1998 and drop-down (ground truth) video taken during the AGDS (acoustic ground discrimination system) trials in Loch Maddy in 1998 and August 1999.

The first stage of the project was to examine remote video footage collected during the Arisaig and Loch Maddy surveys, and the biotope data derived from that video footage. Some inconsistencies in the biotope recording from the video were noted, particularly where the seabed was dominated by kelp. Some basic rules for amalgamating biotopes that could not be consistently identified into larger biotope groupings that could be consistently identified were formulated. These rules were applied to the Arisaig and Loch Maddy datasets, which were then imported into a MapInfo GIS. A methodology for creating biotope maps from the point source data was then devised, using hand-drawn polygons based on knowledge of the relevant biotopes and bathymetric information from an Admiralty chart backdrop. The resulting polygons were labelled and coloured using a standard colour chart to distinguish the biotopes.

The biotopes maps generated by this methodology were then compared with biotope maps previously generated by AGDS. There were significant differences in the distribution and extent of the biotopes in the two sets of maps, due primarily to the inadequate sample site density of the video data. In the inner parts of Loch Maddy and nearshore parts of the Sound of Arisaig the heterogeneity of the seabed biotopes was too great for the sample site density. The remote video data used were not initially collected for the purposes of this project, but the report shows that biotope maps could be compiled with these methods if the site layout was designed to suit the seabed heterogeneity.

An alternative approach to the problem of monitoring biotope extent with remote video data has been suggested. This approach makes no attempt to produce maps from the data, but simply monitors the relative frequency of biotopes recorded by remote video in a defined area. A stratified random sampling regime could provide a consistent and reproducible methodology, which could even give statistically testable results.

A procedural guideline for inclusion in the JNCC / UK Marine SACS Project Marine Monitoring Handbook was prepared for this technique.

1. Introduction

This report describes an assessment of the use of remote video, collected by ROV, towed sledge or drop-down methods, to monitor seabed biotope extent in a marine SAC. ROVs have already been used extensively for descriptive and quantitative surveys and procedural guidelines have been developed for its use in such surveys (Donnan, 1998[2]). Towed and drop-down video have also been used extensively as a ground truthing tool for acoustic ground discrimination systems (AGDS, e.g. RoxAnn and side-scan); the manual for broad scale mapping using AGDS include guidelines for the use of the video for identifying biotopes (Foster-Smith *et al*. 1999). However, neither of these guidelines are sufficient to show whether the video has potential for monitoring biotope extent.

During 1998 and 1999 a series of monitoring trials were carried out using drop-down video (for AGDS ground truthing) and ROV in Loch Maddy, the Sound of Arisaig and Plymouth Sound. Many lessons about video position fixing, sampling intensity of video drops and identification of biotopes from video footage were learnt during this work; but the aims of those monitoring trials did not include an assessment of the use of the video for monitoring extent. However, a large volume of video material, much of which had already been analysed and tagged with biotopes, was produced by those projects, and it was decided that this material could provide the basis for an assessment. The most appropriate material was found to be that from the ROV trials carried out in the Sound of Arisaig in February 1998 and the drop-down (ground truth) video taken during the AGDS trials in Loch Maddy in 1998 and August 1999.

The objectives of this project were therefore as follows:

1. To examine video footage collected during the Arisaig and Loch Maddy surveys using remote video, and the biotope data derived from that video footage, to ensure that the biotopes had been recorded consistently;
2. To compile a set of biotope records from the Arisaig and Loch Maddy datasets that had been identified consistently;
3. To develop guidelines for consistent biotope identification;
4. To develop a methodology for generating biotope maps from the video data;
5. To compare these maps with those prepared from more detailed AGDS survey data;
6. To assess the use of the methods for monitoring biotope extent;
7. To prepare a procedural guideline for the methodology.

[2] This Procedural guideline is being updated and expected to be completed in 2005. It will be updated into the electronic version of the Marine Monitoring Handbook http://www.jncc.gov.uk/page-2430

2. Consistency of biotope identification from remote video footage

The first stage of this project was to assess the consistency with which biotopes have been recorded in previous surveys using remote video. SNH and JNCC provided material from monitoring trials in Loch Maddy and the Sound of Arisaig; where remote video footage was collected using ROV and drop-down video sledge and then analysed by various professional survey ecologists.

The material provided had some limitations for the purposes of the project, due in part to the different aims of the original trials:

- *Arisaig 1998 ROV trials* – the site positions were given (Howson & Donnan, 2000, Table 2) as the centre of the site, even for transect dives. It was therefore not possible to map the distribution of multiple biotopes along the transects. Note: The trial used a fixed transect line to aid comparison of diver and ROV records, and mapping of the biotope data was not intended.
- *Loch Maddy 1999 Drop-down video* – the video provided was edited highlights on VHS rather than SVHS tapes. The quality of the pictures was found to be too poor for accurate biotope identification (due to poor visibility and image clarity, and reduced resolution of VHS). The 1998 tapes were of similar quality and no attempt was made to analyse them. Water depths at the drop-down video sites were not given in the material provided.

[Note: Some of the ROV video was provided as original SHVS master tapes. These were copied onto Sony Hi8 tapes to reduce the risk of damage to the masters, while not significantly reducing the picture quality].

The initial investigation into consistency of biotope recording from remote video concentrated on footage collected by ROV from the SNH Arisaig monitoring trials in February 1998 (Howson and Donnan, 2000). During these trials, biotopes were recorded from a series of dives in the Arisaig area, with biotope identification according to Connor *et al*. (1997). Some of the ROV dives took place along pre-laid transect lines while others were ‘free’ with no fixed points of reference on the seabed.

2.1 Background notes on biotope recording

Biotope recording guidelines are given in the MNCR biotope manual (Connor *et al*. 1997), but workers have found that there are inherent difficulties in assigning biotopes to areas of seabed. Howson and Donnan (2000) reported difficulties in several cases when they tried to match the Arisaig habitats and communities they recorded with the biotope classification of Connor *et al*. (1997). Classification of biotopes can therefore be a very imprecise process, especially when it comes to sediment, mixed substrata and regional variants of national classification types. This is acknowledged in the biotope manual:

> *"The varying levels of data, differing data sources and differing skill levels of users inevitably lead to a complex variety of options as to how best to identify the classification types in your data. Consideration is being given to the*

development of a matching programme to aid future use of the classification, but in the mean time the following general guideline is offered:" etc.

One inevitable problem is how to assign a biotope category to an area of seabed that is a mosaic of many biotopes. There are two factors involved here:

A. Variability within the defined biotope (i.e. many of them encompass lots of sub-biotopes/forms);

B. Complexity in the way that the biotope is found on the seabed - i.e. present in a matrix of other biotopes.

One approach that has been used by some workers for biotope recording has been to assign up to two biotopes to each video shot – a predominant biotope and subsidiary biotope - with an estimate of the proportion of each present. This can make the process a lot easier (and satisfying) for describing a particular area of seabed, particularly when hard and soft (or mixed) substrata are present together (which happens frequently). Preparing biotope maps from such data requires decisions on whether to use patterned fills to map more than one biotope or simply to show the dominant biotope. With modern GIS systems each biotope can be mapped as a separate layer making it easy to present different maps as required.

It must be appreciated, therefore, that the application of the biotope recording methodology is still undergoing development and that *in-situ* surveys by different workers may come to different conclusions, let alone the surveys using remote video. It must also be remembered that biotopes do not exist as discreet and consistently identifiable entities, and that regional variations of the same biotope further complicate the issue.

Despite the above difficulties, Howson and Donnan (2000) concluded that there was relatively little difference between the biotopes recorded by scuba and ROV at the same locations in the Sound of Arisaig, although scuba diving enabled finer discrimination between biotopes.

2.2 Methodology

The methodology used for the assessment of consistency has been through various stages of development. At an early stage of the development, and after consultation, it was agreed that the emphasis of the work was on assessing how consistently the various analysts had assigned the biotopes, rather than on the accuracy of their biotope identification. It was therefore decided that, as far as possible, we should:

1. Limit our assessment to the National Biotope classification, but make note of biotopes that we think have potential for splitting or better definition;

2. Assume that the biotope list for each study area is mostly complete, and only suggest additional biotopes if we think they are important;

3. Not suggest further multiple biotope assignment, unless we consider it important (i.e. we will stick to the predominant biotope).

Adhering to these principles, however, was found to be difficult, because there was often a lack of consistency, not only in the identification of the biotopes, but also in the application of the biotope recording methods.

It has therefore been necessary to apply a three stage approach to assessment of the shots (dives) on the video tapes:

1. To carry out a detailed independent analysis of the biotopes present in the first ten dives (sites one to nine) on the SVHS video tapes from Arisaig (ROV from February 1998). Species lists, abundances and habitat information were recorded using the standard MNCR descriptive terminology described in Hiscock (1996). Procedures for matching biotope records to the classification as detailed in Connor *et al*. (1997, section 3 p.29) were followed in order to determine the biotope present. In order to be consistent with Howson and Donnan (2000) on 'transect dives', only the biotopes visible along the transect line were recorded whereas on 'free dives' all the biotopes were recorded. The results of this analysis are shown in Appendix 1.
2. To carry out a rapid assessment of the remaining shots on the tape (sites 11 to 23) and to record the biotopes present; using the results of the detailed analysis to aid this process. This assessment concentrated on the muddy sediment biotopes and the rock and mixed substrata biotopes (i.e. not the sand and gravel biotopes).
3. To compare the results of the analyses with the biotopes identified in the SNH analysis, and to assess the consistency with which the recording had been made. A shot list detailing the contents of the Arisaig videotapes together with the biotopes recorded at each site was provided by David Donnan of SNH. The results of this comparison are shown in Table 1.

This process was then repeated for the first ten sites of the Loch Maddy 1999 drop-down video footage. The results of this analysis are shown in Appendix 2 and comparison with the SeaMap identifications are given in Table 2.

2.3 Results from analysis of Arisaig ROV video

2.3.1 Initial analysis

Following the initial analysis (before comparison with the SNH records), several obvious factors which could affect biotope recording consistency were already apparent:

- *Mixed Substrata Biotopes*: Mixed substrata with sediment, cobbles and pebbles were encountered on all but Site 2. Difficulties arise when trying to assign biotopes in these habitats, especially in shallow sheltered conditions where red algae and kelps characteristic of the infralittoral occur together with sediments with circalittoral characteristics. The appearance of the biota on these mixed substrata areas will change between winter (when the video was taken) and summer when vegetation cover will increase dramatically. This seasonal change further complicates correct biotope identification (and so consistent recording) of these habitats. Connor *et al*. (1997) does not adequately cater for field identification of mixed substrata biotopes.
- *Gradients*: Gradients from boulders to fine sediment occurred in several instances, especially on transects between shallow and deep water. Determining when biotopes change along a gradient (and which biotopes are present) can be very subjective and so affect consistency of recording. Connor *et al*. 1997 (p27) recommends that a biotope should extend over an area of at least 5m x 5m.

Whether or not such an area is visible on video footage will depend on how the ROV was 'flown' on the day.

- *Kelps*: In very sheltered conditions such as those encountered during some of the Arisaig dives, *Laminaria hyperborea* and *Laminaria saccharina* can be very difficult to distinguish in the field and even more so from video footage. The difficulties of seeing the understorey below the kelp canopy creates further problems for identification. Seasonal differences will also occur. All of these factors will affect the consistency in recording of kelp biotopes.
- *Sediment Biotopes*: The identification of sediment biotopes by purely visual methods is problematical, as the key infaunal species cannot be seen and the surface texture may not give adequate information on the sediment habitat characteristics. This will greatly affect the ability to distinguish biotopes and the consistency of recording.

2.3.2 Comparison with the SNH records

Rapid assessment of the remaining sites on the video tape was then carried out and the results included in Table 1. A comparison was then made of the results from this study (detailed and rapid) with the SNH records for the same sites. This comparison found that there was fairly good agreement between the two analyses in the identification of many of the biotopes identified, but that there were a number of significant differences in the recording of some biotopes and with some recording protocols. The areas where differences in recording were found are as follows:

Site 1a: IMX.LsacX was recorded in this study but not by SNH. The complication of mixed substrata biotopes occurred here. This study decided that the area covered by *Laminaria saccharina* and foliose algae visible warranted the inclusion of IMX.LsacX as a biotope found at this site. SNH probably decided only to record the main sediment biotope. This is probably not so much a consistency problem but one of recording protocol.

Site 4: The difficulty of identifying kelps in sheltered habitats occurred here. This study recorded EIR.Lsac.Lsac as present whereas the biotope was identified as MIR.LhypGz.Ft. Also, CMS.VirOph was recorded in the present study but was not recorded by SNH.

Site 5: This transect extended from waves of maerl gravel to shallow kelp forest. This study recognised a transition of three biotopes on the rock (each covering an area of more than 5m x 5m): grazed rock dominated by crustose corallines (EIR.CCParCar) leading to kelp park (MIR.LhypGz.Pk) and eventually to kelp forest (MIR.LhypGz.Ft). The SNH study only recognised one biotope here, MIR.LhypGz.Ft. Comparison with the SNH records from Site 3, where three biotopes were identified from a similar gradient, highlights an inconsistency in the criteria used to separate biotopes along such gradients.

Site 9: The video was taken in bad visibility and it's difficult to see much except close up. Consistency in recording will be affected by visibility as well as skill in flying the ROV.

Site 13 CMU.SpMeg to 12.4m, then VirOph to 8.8m. SNH recorded CMU.SpMeg throughout this area. This highlights a difficulty with sediment biotopes. CMU.SpMeg occurred deep but then appeared to grade into CMS.VirOph in shallower water (Nephrops burrows disappeared but still the odd *Virgularia* about and the sediment was not so muddy). The record of CMU.SpMeg throughout is probably fair enough if it had been decided that the biotopes could not be differentiated in previous dives.

The mud was then followed by an area of sediment with scattered cobbles, pebbles and shell with foliose weeds including one or two *L. saccharina* and *Desmarestia*. This is not IMX.LsacX but more like IMX.KSwMx.

Finally, the video goes onto grazed boulders with mixed kelps including *L. saccharina* and *Saccorhiza polyschides*. This is considered to be either SIR.Lsac.Pk or MIR.XKScrR (not possible to distinguish, particularly at this time of year) whereas SNH recorded it as MIR.LhypGz.Pk.

Site 14: CMS.VirOph was present for a significant part of this site, especially around 13.2m depth on transect. SNH recorded CMU.SpMeg throughout.

Site 17: SIR.LhypLsac.Pk recorded by SNH. This may be correct, but it could be MIR.XKScrR. The two biotopes are difficult to distinguish, particularly at this time of year.

Site 18: ECR.CCParCar present over wide area with no *Laminaria saccharina*. A typographical or data transfer error may have occurred here.

Site 19: All rippled sand + red algae on stones and *Lanice*. But kelp biotopes were recorded by SNH. It is possible that a typographical or data transfer error occurred here.

Site 20: Mostly gravel and sand, some kelp. All kelp biotopes recorded by SNH. A typographical or data transfer error may have occurred here.

Table 1. SNH dive log for Arisiag Monitoring Trials, February 1998 showing biotopes encountered during each dive, together with the biotopes recorded from these dives in the present study.
Dive type: Spot = single bounce dives of short duration for ground-truth purposes; Transect = Dives along 50m transect rope; Free Dive = Dive carried out in immediate vicinity of transect, for set period, but with no visual datum to follow.

Fiel site	Rep. site	Dive type	Biotopes recorded by SNH	Biotopes recorded during the present study	Match?
1a	34	Free, with 1b	VirOph	VirOph	Yes
1b	33	Transect	VirOph	VirOph	Yes
2	45	Spot	SpMeg	SpMeg	Yes
3	31	Transect, with 4	LsacSac, LsacX, VirOph	LsacSac, LsacX, VirOph	Yes
4	32	Free	LhypGz.Ft, LsacX	LsacX, LsacSac, VirOph	No
5	39	Transect, with 6	LhypGz.Ft, Phy	LhypGzFt, Phy, CCParCar, (LsacX)	Partial
6	40	Free	LhypGz.Ft, Lsac.Pk, Phy	LhypGz.Pk, CCParCar, IGS, LhyppGz..Ft	No
7	48	Spot	?Sand/algae	IGS	Yes
8	49	Spot	Phy.R	IGS	No
9	50	Spot	?muddy sand	IMS	Yes

10	41	Transect	Phy.R	Phy.R	Yes
11	38	Free, with 12	Phy.R, LhypGz.Ft	Phy.R, LhypGz.Ft	Yes
12	37	Transect	Phy.R, LhypGz.Ft	Phy.R, LhypGz.Ft	Yes
13	30	Free, with 14	LhypGz.Pk, LsacX, SpMeg	SpMeg, VirOph, KSwMx (narrow zone before boulders), Lsac.Pk or XKScrR.	Partial
14	29	Transect	SpMeg	SpMeg, VirOph	Partial
15	43	Spot	SpMeg	SpMeg	Yes
16	44	Spot	SpMeg	SpMeg	Yes
17	36	Free, with 18	LhypLsac.Pk, VirOph	LhypLsac.Pk or XKScrR, VirOph	Yes
18	35	Transect	Lsac.Pk, VirOph	CCParCar, VirOph	Partial
19	27	Transect, with 20	LhypGz.Ft, LhypGz.Pk, LsacX	rippled sand + red algae on stones + *Lanice*	No
20	28	Free	LhypGz.Ft, LhypGz.Pk, LsacX	Mostly gravel and sand, some kelp	No
21	42	Spot	SpMeg	SpMeg	Yes
22	47	Spot	LhypGz.Ft	Lhyp.Ft	No
23	46	Spot	Lhyp.Ft, Phy	Lhyp.Ft, Phy	Yes

2.4 Notes from analysis of Loch Maddy drop-down video

Consistency problems were as follows:

- Seven biotopes were recorded by SeaMap but only five by this study of which two were agreed in common. It is difficult to agree consistency in recording with this lack of agreement.
- The lack in agreement is partly due to SeaMap classifying to a finer level than FB found possible eg IMS.FaMS and IMS.FaMx. Due to video quality and content classification could only be achieved to the level of IMS in this study. It is therefore impossible to gauge the consistency at which these two biotopes were recorded.
- There were four sites where SeaMap recorded IMX.LSacX but this was not recorded during this study (sites 1,3,9 and 10)
- LhypLsac.Pk was recorded at sites at three sites by Seamap but not during this study (sites 4,6 and 8). (LsacX was recorded by this study at site 4).
- It is possible that kelp biotopes could not be distinguished properly from the video copy. Also, it may be that different workers have different ideas about the definition of kelp park and forest (and species id!).
- SeaMap recorded maerl Phy.R at site 6. This was not recorded by the present study.

Table 2. SeaMap drop-down (ground truth) video sites for Loch Maddy AGDS monitoring Trials, August 1999 showing biotopes identified from each dive, together with the biotopes identified from these dives in the present study.

Site No.	Biotopes recorded by SeaMap	Biotopes recorded during the present study	Notes
1	IMS.FaMS	IMS	Little fauna or flora shown on the video and what is there is difficult to distinguish.
2	IMX.FaMx (MIR.Lhyp.Pk)	IMX (LhypLsac.Ft)	Mixed dense *Laminaria saccharina* and *Laminaria hyperborea* on the rocky areas.
3	IMX.FaMx (1)	IMX	Little fauna or flora shown on the video and what is there is difficult to distinguish.
4	LhypLsac.Pk (SIR.Lsac.Ft)	SIR.Lsac	Can't distinguish two kelp biotopes from the video
5	MCR.ErSSwi (IMS.FaMS)	IMX (IMX.LsacX)	Three spots on map so presumably a drift over approximately 70m.
6	IGS.Phy.R	IMX	Four spots on map so presumably a drift over approximately 100m.
7	IMX.LsacX	IMX (IMX.LsacX)	
8	IMX.LsacX (SIR.Lsac.Ft)	IMX.LsacX	Only one biotope seen on the video.
9	IMX.LsacX	IMX	No signs of kelp other than one or two plants. Maybe edited video did not show the kelp?
10	IMX.LsacX	IMX	No signs of kelp other than one or two plants. Maybe edited video did not show the kelp?

SeaMap appear to have been able to record more than is evident from the edited highlights. Discussion with SeaMap confirmed that some of the 1999 video footage had been reviewed by an independent marine biologist diver with considerable experience of the subtidal biotopes present in the Loch Christine Howson), but it was not known if any other information had been used to supplement the video footage (Bob Foster-Smith, pers. comm.).

The image resolution of VHS video is generally not good for species identification and therefore limits biotope identification. Features of conservation interest such as maerl beds can be missed and biotopes can often only be identified to a higher level biotope group.

Depth information was not given for the video sites. This is essential to help determine the classification of biotopes (e.g. infralittoral or circalittoral). An estimate could be made from an admiralty chart but as chart accuracy is often questionable, this not sufficiently reliable for mapping purposes.

2.5 Conclusions and discussion

Assessment of the Arisaig video found a number of notable differences in the biotope identifications recorded by SNH and by this study. Some of these differences are so great that they must be due to intentional exclusions in the footage analysed by SNH or typographical errors, but some are due to differences in the identifications made by the recorders. Of the latter, some are due to a difference of opinion, which is consistently applied, but a few are due to inconsistencies in the recording. The aim of the analysis was to concentrate on identification of the inconsistencies, but differences in opinion could also produce inconsistencies in future monitoring surveys if area-specific notes on biotope identification are not prepared.

The main differences were in the identification of kelp biotopes. For example, there was some inconsistency in the identification of the kelp park biotopes, e.g. *LhypGz.Pk*, *Lsac.Pk* and *XKScrR*, and the kelp forest biotopes, e.g. *LhypGz.*Ft and *LsacSac*. It is very difficult to distinguish between *Laminaria saccharina* and *Laminaria hyperborea* in very sheltered conditions such as those found in Arisaig and Loch Maddy (Christine Maggs, pers. comm.).

There was also scope for problems with other biotopes. For example, the maerl biotope *Phy.R* was applied to all areas of infralittoral gravel that contained recognisable maerl in the SNH records, but assessment during this project suggested that some areas had too little maerl to warrant that tag.

Assessment of the Loch Maddy video also found a number of notable differences in the biotope identifications recorded by SeaMap and by this study. Most of these differences were due to the quality of the video, but some inconsistency in the identification of kelp biotopes (e.g. *LhypLsac.Pk*, *Lsac* and *Lsac.Ft*) was also apparent.

The difficulties of identifying kelp biotopes from drop-down video were highlighted in the SeaMap report on the Loch Maddy 1999 trials (Foster-Smith *et al*. 2000). Their comparison of biotope identifications from 1998 and 1999 video records showed large differences in the records from sheltered parts of Sponish Harbour where kelp dominated. While some of these differences may have been due to positional differences and the high level heterogeneity of this area, it was thought that inconsistency in identification of kelp biotopes was important. Howson and Donnan showed that the ROV records tended to produce more *Laminaria* biotope records than divers surveying the same locations, but they did not assess the consistency of the records.

It is concluded from the above that some biotopes will need to be grouped to improve consistency of identification from remote video footage. One way to approach this grouping would be to use the ‘biotope complexes’ that have already been defined in the biotope manual (Connor et al., 1997). However, the biotope complexes were not designed to aid identification of biotopes and considerable information would be lost by applying them across the whole range of biotopes present. For example, the ‘Infralittoral mixed sediment’ complex includes the biotopes LsacX and FaMx, which can be consistently differentiated in remote video footage. Furthermore, application of the biotope complexes may not remove all problems of inconsistency; for example the infralittoral rock biotopes SIR.Lsac.Pk and MIR.XKScrR are from different biotope complexes, but may not always be differentiated, particularly if the survey is carried out in the winter.

It is therefore recommended that biotopes are grouped using a set of rules that are defined by the discriminatory abilities of the remote video method, the local conditions and the season in which the survey is carried out. As a general rule, the infralittoral kelp biotopes from sheltered and moderately exposed areas may need to be grouped into just two ‘Biotope Groups’ – upper infralittoral kelp forest and lower infralittoral kelp park. Table 3 shows the complete list of biotopes present in both the Arisaig and Loch Maddy datasets, and shows how some of the biotopes were grouped to reduce any inconsistencies in their identification. These groupings were then applied to the datasets in the mapping procedures described in the next section.

Table 3. Biotopes recorded in the Sound of Arisaig and Loch Maddy. Biotope codes are according to Connor et al., (1997). The biotope complex prefixes are: EIR = Exposed infralittoral rock; MIR = Moderately exposed infralittoral rock; SIR = Sheltered infralittoral rock; IGS = Infralittoral gravels & sands (incl. maerl); IMS = Infralittoral muddy sands; IMU = Infralittoral mud; IMX = Infralittoral mixed sediment; ECR = Exposed circalittoral rock; MCR = Moderately exposed circalittoral rock; CGS = Circalittoral gravels & sands; CMS = Circalittoral muddy sands; CMU = Circalittoral mud. The Biotope Group codes indicate which biotopes have been grouped in this study, for mapping and monitoring purposes.

Biotope code	**Biotope Group**	**Biotope name**
EIR.LsacSac	1	*Laminaria saccharina* and/or *Saccorhiza polyschides* on exposed infralittoral rock
EIR.FoR	2	Foliose red seaweeds on exposed or moderately exposed lower infralittoral rock
MIR.Lhyp.Ft	3	*Laminaria hyperborea* forest and foliose red seaweeds on moderately exposed upper infralittoral rock
MIR.LhypGz.Ft	3	Grazed *Laminaria hyperborea* forest with coralline crusts on upper infralittoral rock
MIR.Lhyp.Pk	4	*Laminaria hyperborea* park and foliose red seaweeds on moderately exposed lower infralittoral rock
MIR.LhypGz.Pk	4	Grazed *Laminaria hyperborea* park with coralline crusts on lower infralittoral rock
MIR.Lhyp.TPk	4	*Laminaria hyperborea* park with hydroids, bryozoans and sponges on tide-swept lower infralittoral rock
MIR.Ldig.Ldig	5	*Laminaria digitata* on moderately exposed sublittoral fringe rock
MIR.Lhyp.TFt	3	*Laminaria hyperborea* forest, foliose red seaweeds and a diverse fauna on tide-swept upper infralittoral rock
MIR.HalXK	6	*Halidrys siliquosa* and mixed kelps on tide-swept infralittoral rock with coarse sediment
SIR.LhypLsac.Ft	3	Mixed *Laminaria hyperborea* and *Laminaria saccharina* forest on sheltered upper infralittoral rock
SIR.Lsac.Ft	3	*Laminaria saccharina* forest on very sheltered upper infralittoral rock
LhypLsac.Pk	4	Mixed *Laminaria hyperborea* and *Laminaria saccharina* park on sheltered lower infralittoral rock
SIR.Lsac.Pk	4	*Laminaria saccharina* park on very sheltered lower infralittoral rock
SIR.Lsac	3	*Laminaria saccharina* on very sheltered infralittoral rock

Biotope code	**Biotope Group**	**Biotope name**
SIR.LsacRS	3	*Laminaria saccharina* on reduced or low salinity infralittoral rock
SIR.LhypLsac	3	Mixed *Laminaria hyperborea* and *Laminaria saccharina* on sheltered infralittoral rock
IGS	7	Infralittoral gravels and sands
IGS.Mrl	8	Maerl beds (open coast/clean sediments)
IGS.Phy	8	*Phymatolithon calcareum* maerl beds in infralittoral clean gravel or coarse sand
IGS.Phy.R	9	*Phymatolithon calcareum* maerl beds with red seaweeds in shallow infralittoral clean gravel or coarse sand
IGS.Lgla	8	*Lithothamnion glaciale* maerl beds in tide-swept variable salinity infralittoral gravel
IMS.FaMS	10	Shallow muddy sand faunal communities
IMS	10	Infralittoral muddy sands
IMU.MarMu	11	Shallow marine mud communities
IMU.PhiVir	11	*Philine aperta* and *Virgularia mirabilis* in soft stable infralittoral mud
IMU.AreSyn	12	*Arenicola marina* and synaptid holothurians in extremely shallow soft mud
IMX.FaMx	13	Shallow mixed sediment faunal communities
IMX.KSwMX	14	*Laminaria saccharina* (sugar kelp) and filamentous seaweeds (mixed sediment)
IMX.LSacX	14	*Laminaria saccharina*, *Chorda filum* and filamentous red seaweeds on sheltered infralittoral sediment
ECR.CCParCar	15	Coralline crusts, *Parasmittina trispinosa*, *Caryophyllia smithii*, *Haliclona viscosa*, polyclinids and sparse *Corynactis viridis* on very exposed circalittoral rock
ECR.AlcMaS	16	*Alcyonium digitatum* with massive sponges (*Cliona celata* and *Pachymatisma johnstonia*) and *Nemertesia antennina* on moderately tide-swept exposed circalittoral rock
MCR.ErSSwi	17	Erect sponges and *Swiftia pallida* on slightly tide-swept moderately exposed circalittoral rock
MCR.FaAlC	18	Faunal and algal crusts, *Echinus esculentus*, sparse *Alcyonium digitatum* and grazing-tolerant fauna on moderately exposed circalittoral rock
CGS	19	Circalittoral gravels and sands
CMS	20	Circalittoral muddy sand
CMU	21	Circalittoral mud
CMU.SpMeg	22	Seapens and burrowing megafauna in circalittoral soft mud
CMU.VirOph	23	*Virgularia mirabilis* and *Ophiura* spp. on circalittoral sandy or shelly mud

It is emphasised that, while the reasons for defining site/project specific Biotope Groups are apparent, the decision to modify the standard biotope ‘classification’ should not be taken lightly. New Groups should only be used if existing (standard) groupings are not appropriate, and the rules for defining any such Groups must be clearly laid down. The Groups themselves should also be described in terms of biological & physical characteristics that can be easily identified by subsequent workers.

3. Mapping the biotopes

From the above results it is concluded that some minor editing of the biotope records to group some of the kelp park biotopes (particularly LhypLsac.Pk, *LhypGz.Pk*, *Lsac.Pk*) and group some of the kelp forest biotopes (particularly *LhypGz.*Ft and *LsacSac*) could provide a reasonably consistent dataset from the Arisaig ROV video records, without greatly reducing the information content. As it had not been possible to carry out a detailed assessment of the consistency of the Loch Maddy drop-down video records it was decided to apply the same Biotope Groupings derived from the Arisaig analysis to this data. This was done for the purposes of this project only, as the large Loch Maddy dataset provided the best opportunity of testing the mapping procedures.

3.1 Arisaig maps

The Biotope Groups given in Table 3 were therefore applied to the Arisaig dataset and entered into MapInfo (c.f. Appendix 3). A raster scan of the local Admiralty chart was also imported and registered in MapInfo to form a backdrop to the sites. This showed that the positions of the sites had been entered correctly. The next stage in the mapping process was to colour code the ROV video sites according to the standard biotope complex colours given in Connor *et al*. (1997, p34, Plate 1). This site map is given in Figure 1. Where a site was tagged with more than one biotope, the colour code for the first listed biotope was used. As many of the biotope complexes included more than one Biotope Group these standard colours were not sufficient to distinguish all of the Groups, but they provided an initial aid to the biotope mapping.

An attempt was then made to create a map of the Biotope Groups, using the colour coding of the biotope complexes, the additional attributes of the sites in the MapInfo table and the features of the underlying chart to indicate the most likely extent of each biotope. This was not an automated procedure - partly because the software to carry out such a procedure was not available for this study, but also because it was not considered appropriate. It is recognised that a ‘semi-automated’ approach might be possible - using basic spatial analysis to derive a continuous surface of polygons around the sites (Thessian polygons or a nearest neighbour type interpolation) and then intersect them with a bathymetry layer to provide appropriate ‘restrictions’ to some biotopes (e.g. depth limits for kelp), followed by some manual editing in GIS. However, it is considered unlikely that the effort required to set-up such a process would provide adequate reward, unless a much higher density of sites was available. There are many ecological factors, including the typical habitat preferences and depth profiles of each biotope, to consider when preparing such maps; and the automated procedures would only remove a small part of the whole thought process. It is more important that the mapping procedure is based on first hand knowledge of the relevant biotopes, preferably with experience of the local conditions. Some valuable experience can be gained from study of the video footage of long transects and from long drop-down video tows.

Some of these issues are highlighted in the biotope map prepared from the Arisaig data (c.f. Figure 2). In some cases, the site data and the bathymetry shown on the chart indicated that a biotope extended across a wide area or in a narrow strip along a long stretch of coast. In these cases, the map polygons were drawn considerably larger or longer than the site data alone could support, and are presented as predictions of how the biotopes may be distributed. For example, the circalittoral muddy biotopes SpMeg and VirOph are likely to dominate areas of level seabed below 20m. The chart shows that a large area of seabed off Arisaig is relatively featureless and deep and it does not require many ground-truthed sites in this area to indicate the biotope distribution in this area. In other areas, the heterogeneity of the seabed was too great to allow any such predictions, and the polygons were limited to small areas immediately surrounding the data points.

This attempt at mapping the distribution of the Arisaig biotopes was greatly limited by the lack of dive site positions, particularly for the transect records where a single central position was given for 3 or more biotopes. The Arisaig ROV surveys were not intended for mapping purposes, and the positions were therefore not designed to represent all of the biotopes or the whole area. Nevertheless, the map does show some of the potential of the method.

3.2 Loch Maddy maps

The method was then applied to the Loch Maddy drop-down video data from the SeaMaps surveys of 1998 and 1999. The two sets of survey data were combined to provide a large number of sites in the Loch. There was a particularly high density of sites in Sponish Harbour. As described at the end of Section 2.5, the Biotope Groups derived from the Arisaig analysis (c.f. Table 3) were also applied to the Loch Maddy data, although this would not normally be recommended. There were some differences in the suite of biotopes present in Loch Maddy compared to those analysed from Arisaig, but the same basic rules were applied. It is thought that this procedure should greatly improve the consistency of the biotope records for the Loch Maddy dataset.

An improvement of the biotope map presentation was used for the Loch Maddy GIS, using transparent fills and different pattern densities to distinguish the Biotope Groups. The site map and the biotope map are given in Figures 3, 4 and 5. They show, as described in Foster-Smith *et al*. (2000), that the heterogeneity of the seabed at the inner end of Sponish Harbour was much greater than the outer end of the Harbour. It was therefore difficult to predict the distribution of the biotopes in this area, but relatively easier elsewhere. Once again, the main purpose of the drop-down video records was for ground-truthing of the AGDS survey data, rather than broad scale biotope mapping; but the larger dataset did provide a better test of the method. Comparison of Figure 4 with the biotope maps prepared from the AGDS survey data in Foster-Smith et al. (2000) show a number of differences. Figure 4 appears to have underestimated the amount of maerl, FaMS and FaMX, while over-estimating LsacX. This is due in large part to the inadequacies of the site layout for biotope mapping purposes, and could be greatly improved.

3.3 Conclusions

The biotope maps prepared from the Arisaig and Loch Maddy remote video data are considered inadequate for monitoring purposes. Even the Sponish Harbour map has large gaps where reliable predictions of biotope distribution were not possible. Furthermore, the sizes and boundaries of many of the polygons that have been drawn are not considered reliable enough for monitoring, because identification of even gross changes (e.g. where a biotope area increases or decreases by 3 or 4 times) may not be possible.

However, the mapping processes described above have provided a number of insights into the potential use of spot site biotope data for mapping. This is discussed further in the next section.

4. General discussion and recommendations

The results of this study have shown that seabed biotope identification from remote video footage (used as a stand-alone tool) has limitations, particularly in areas dominated by kelps, but suggests that consistency need not be too poor if strict protocols are applied and certain biotopes are grouped. Identification and consistency can also be further improved if biotope records from the baseline survey are thoroughly analysed to highlight potential problems in advance and if area specific guidelines are then developed to assist the surveyors carrying out future monitoring. If possible, ground truthing of biotopes using diving biologists at selected sites would add further quality assurance to data sets.

The results have also highlighted the inadequacies of the data that were used in this study for preparing biotope maps. The video was not originally taken with the aim of biotope mapping over a large area solely based on this method. Even the large number of sites in Sponish Harbour, Loch Maddy, was inadequate to prepare a reliable map that could be used for monitoring purposes. This was due to the extreme heterogeneity of the seabed in this area, and the additional information available in the Admiralty chart was not enough to predict the distribution patterns. If the chart had provided more detailed information on the basic distribution of rock and sediment, a much better prediction would have been possible with the video data available. If the site layout had been designed to take advantage of such detailed chart information, an even better prediction would have been possible, and might then be adequate for monitoring purposes.

This lack of inadequate data also limited the potential for this assessment; but it is understandable that the study did not warrant a pilot field study, given the volume of video data already available. Nevertheless, if remote video is to be used for monitoring biotope extent in the future, it is essential that the surveys are designed for this purpose; and in particular, that the sampling strategy (i.e. the distribution of the survey sites) is adequate to give the required level of detail. If it is possible to acquire more detailed information on the distribution of rock and sediment in the area (e.g. by side-scan sonar) in advance of the remote video survey, fewer survey sites will be required for a good biotope map.

The greatest problem for any survey or sampling technique used to describe the seabed is the high level of heterogeneity, at a range of spatial scales. In this respect, the remote video has similar limitations to a grab sampler used for mapping sediment communities – the number of sampling points should be based on the level of seabed heterogeneity. If too few points are sampled, the map is likely to give a very poor representation of reality, even if you have a very accurate chart of the bathymetry to assist the mapping process. If a series of such maps are produced during a monitoring programme, they are likely to confuse anybody attempting to interpret them. It is therefore recommended that the surveys should be stratified, or targeted at particular features of interest (e.g. focussed upon an area which is known to be under some threat of change).

Even if the number of video sites is adequate to produce a representative biotope map of the seabed area, the value of using maps for monitoring biotope extent is questioned. It is suggested that their greatest use in this respect, will be to aid visualisation of changes that have been identified by other means. However, it is suggested that biotope records collected by remote video could provide the monitoring data needed to detect changes in extent, without need for mapping. One of the difficulties of mapping biotopes is how to portray records that include more than one biotope – either a primary biotope and one or more subsidiary biotopes, or two biotopes of level dominance in a heterogeneous area. However, while these data are difficult to use for mapping it could be of greater use for calculating and statistically analysing biotope extent in a defined area.

The following sections provide recommendations for the design of stratified surveys, the protocols for biotope identification and the methods that could be used for mapping the data and calculating biotope extent.

4.1 Survey strategy and sampling intensity

1. Approximately divide area into probable zones/major habitats/biotope complexes (e.g. sublittoral fringe zone, infralittoral zone, circalittoral zone, rock platforms, sediment plains, dredged channels etc.) based on pre-survey information (e.g. bathymetry, other charted information, known uses of area, and existing survey data). Note: use Admiralty chart backdrop in GIS to assist this process.
2. Use GIS to generate table of random site positions within each of these ‘zones’. An alternative and simpler approach would be to generate a grid pattern of sites in each zone, but this may limit the opportunities for unbiased statistical analysis of the data (regular arrangement may contravene the assumptions of some statistical tests). If such tests are not required or are fairly robust then a regular grid data may be more appropriate.
3. Carry out surveys of the spot sites in a zone, in a random or semi-random order. Do not simply start at one end and progress towards the other end, because then you would not be able to take advantage of the possibility that the seabed biotopes are homogenous and you can limit the number of sites. Continue to survey sites from each zone until:

   i) you have not found any additional biotopes for the zone in the last 3 surveyed sites; and

   ii) you have at least 4 times as many sites as there are biotopes in the zone.

   Note: record actual positions of survey sites as well as the intended random positions.

If you do not have a good understanding of the typical zonation patterns, depth profiles of biotopes and heterogeneity of the seabed in the survey area, a series of long tows of the video across the area will provide useful information to aid the mapping process. However, it will be difficult to fix positions of biotopes and to handle the data from such tows, so it may not be possible to map it directly.

4.2 Development of a consistent dataset

To use the video records for monitoring biotope extent will require a high degree of consistency if it is to produce valid results. Improvements in recording are possible if one develops rules and crib notes to help the surveyors recognise biotope characteristics and make decisions in borderline cases. Video frame capture images can also be used to assist this process, and were found to be very useful during the Loch Maddy 1999 survey. These notes and photographs should be retained for the life of the monitoring programme.

Foster-Smith *et al*. (2000) discussed the various reasons for inaccuracy and inconsistency of biotope records, and developed a useful protocol for tagging records according to the heterogeneity of the seabed (c.f. Table 4.).

This protocol handles video records that include more than one biotope by tagging them with more than one biotope (usually a primary/predominant biotope and one or two subsidiary biotopes). It has been pointed out in Section 2.1 above, that mapping records that are tagged with more than one biotope can make mapping more complicated; however, it is considered important that the data on subsidiary biotopes are recorded. If the data are to be mapped it would also be very useful if video records which happened to include a transitional biotope, or a boundary between two biotopes, was tagged as such.

Table 4. Protocol for tagging samples according to the heterogeneity of the seabed as viewed from the video. (modified slightly from Foster-Smith *et al.* 2000)

Heterogeneity of the video	Protocol for tagging samples
1. Recording is of one single, unambiguous biotope representing 100% of the record.	One biotope tag.
2. Record is of two or more biotopes along a tow, but the biotopes are separated from each other by distance (heterogeneity at the video tow scale)	Tow is divided into two or more records and the position of each record estimated from time that elapsed between the start of the tow, the total time of the tow and the total distance of the tow. Each record given one biotope tag.
3. The viewer is uncertain as to which biotope tag to use because of poor correspondence with biotope classes in Manual.	The most favoured option is used to tag the record provisionally, but other possible classes noted. Examples of records should be referred to a biologist with knowledge of the biotopes in the region.
4. Key features or species can not be recognised from the video.	The record is tagged with higher class, life form category or sediment type as appropriate.
5. The record shows a mixture of two or more biotopes arranged patchily* within a single video frame (heterogeneity at a video frame scale).	The record is tagged with the predominant biotope but an estimate given as a percentage of the constituent biotopes. The record is also tagged as containing a boundary between biotopes (to distinguish from 6).
6. The record has features which indicate that it could be regarded as lying between two or more biotope classes**. For example, very small quantities of *Laminaria saccharina* on sand could be considered as partially belonging to both a kelp and a sandy biotope.	The record is tagged with the most likely biotope, but an estimate of the degree of membership to each biotope given as a percentage value. If the record is patchy, these percentages are estimates of cover. The record is also tagged as containing a transitional biotope (to distinguish from 5).
Note that both patchy biotopes* and biotopes laying along a continuum** can be expressed as percentages which are estimates of the degree of membership to the component biotope classes.	

1. During the process of compiling biotope data from the video the recorder should be mindful of the need for consistency and should make notes of any biotopes that may not be distinguished reliably. If a high level of consistency is imperative, it may be necessary to have an independent review of 5 or 10% of the video records. If the

video is from a repeat survey it may be useful to compare video shots from previous years with those from the present year to aid biotope identification.

2. Once the recording has been completed, decide on a list of biotopes and biotope complexes that is a reasonable compromise between consistency / accuracy of recording and the need to maximise the information content. It is possible that this process will require some additional viewing and comparison of video from selected sites where identification was difficult. The more that the surveyors carry out such comparisons, the better they will get at making the decisions. It is important that as much of this experience as is reasonably possible should be written down in the form of guidelines and simple procedures for future use.
3. Edit table of records with the revised biotope/ biotope complex codes, then sort the table into a logical order based on biotope types.
4. Monitoring surveys – use same list of biotopes and biotope complexes. If changes to the biotope complexes are required, re-analyse video from previous surveys with new definitions.

4.3 Mapping biotopes/biotope groups

The next stage is to use the data to prepare a biotope map, if such a map is required.

1. Assign colour codes to the biotopes groups, based on the standard colour chart in the biotope manual (Connor et al., 1997) or other appropriate colour chart.
2. Import table into MapInfo and use colour codes to label spot sites.
3. Draw polygons around sites of the same colour to approximate the boundaries between the biotopes. It is important that this process is based on first hand knowledge of the relevant biotopes (i.e. their typical habitat preferences and depth profiles), preferably with experience of the local conditions. Use bathymetry information in the Admiralty chart backdrop to assist with the process. Colour the polygons according to the colour chart and appropriate pattern styles.

4.4 Estimating biotope extent from statistical analysis of biotope records

Another approach to the monitoring of biotope extent, using the remote video data, is to calculate the relative proportions of the biotopes present in the data, rather than attempting to map the biotopes and estimate extent from the maps. It would then be possible to use the information provided by the multiple biotope records, which is largely ignored by the mapping procedures. It would then be possible to objectively monitor changes in the relative proportions of the biotopes with statistical calculations, rather than subjective assessment of changes in mapped distributions. If enough data were collected it would also be possible to devise significance tests (using randomly generated subsets of the data) to calculate the probability that changes have occurred. If changes were identified, it may then be appropriate to create maps from the data to highlight the areas where the changes occurred and focus further studies on those areas.

The Countryside Council for Wales have carried out some trials in the Mawddach estuary to test the use of biotope recording to monitor the relative proportions of intertidal muddy and sandy communities throughout the estuary (Wyn and Cooke, 2001). Broad scale mapping of the estuary had already been carried out and had provided a picture of the relative proportions and positions of muddy/sandy biotopes present. However, while it was expected that the positions of the biotopes might change, it was considered important that the proportions of mud to sand biotopes should remain broadly stable if the estuary were to continue in its present state. The Phase 1 methodology was therefore used to survey 143 stations on an evenly spaced grid of sampling sites across the whole estuary and calculate the relative proportions of the biotopes. The results were compared with those from a Phase 2 (sediment core analysis) survey of the same grid of stations. The two surveys agreed on the biotope identifications from all of the rocky or mixed sediment stations, but agreed at only 66% of the sediment biotope stations. The differences were mainly due to an underestimate of mud in the sediment by the Phase 1 surveyors.

CCW consider that the Phase 1 method has potential use for future monitoring and plan to use it in their monitoring programme for the Mawddach Estuary (Bill Sanderson, pers. comm.).

5. References

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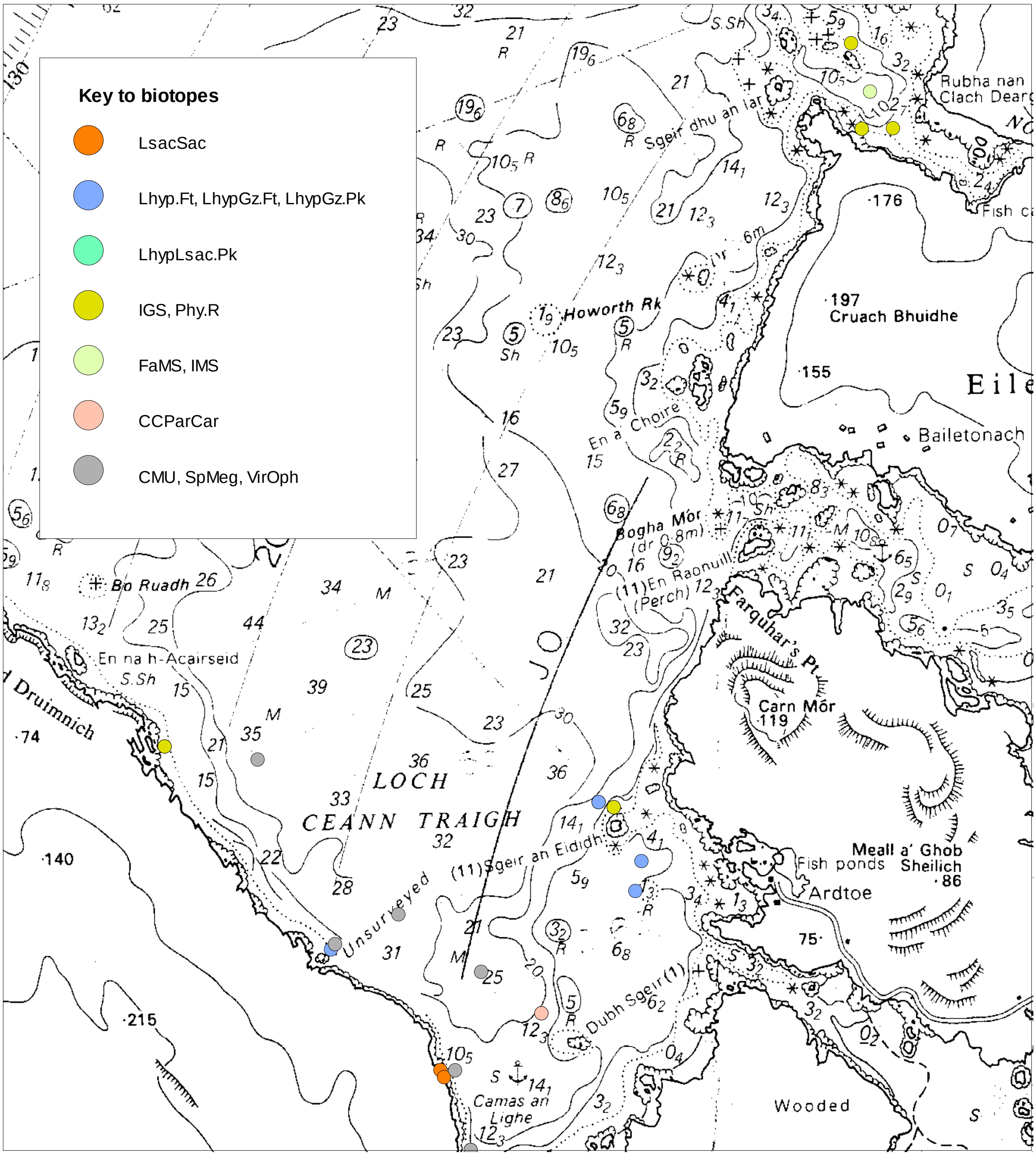

Figure 1. ROV survey sites (1998) in the Sound of Arisaig, colour coded according to the standard biotope colour chart given in Connor *et al*. (1997)

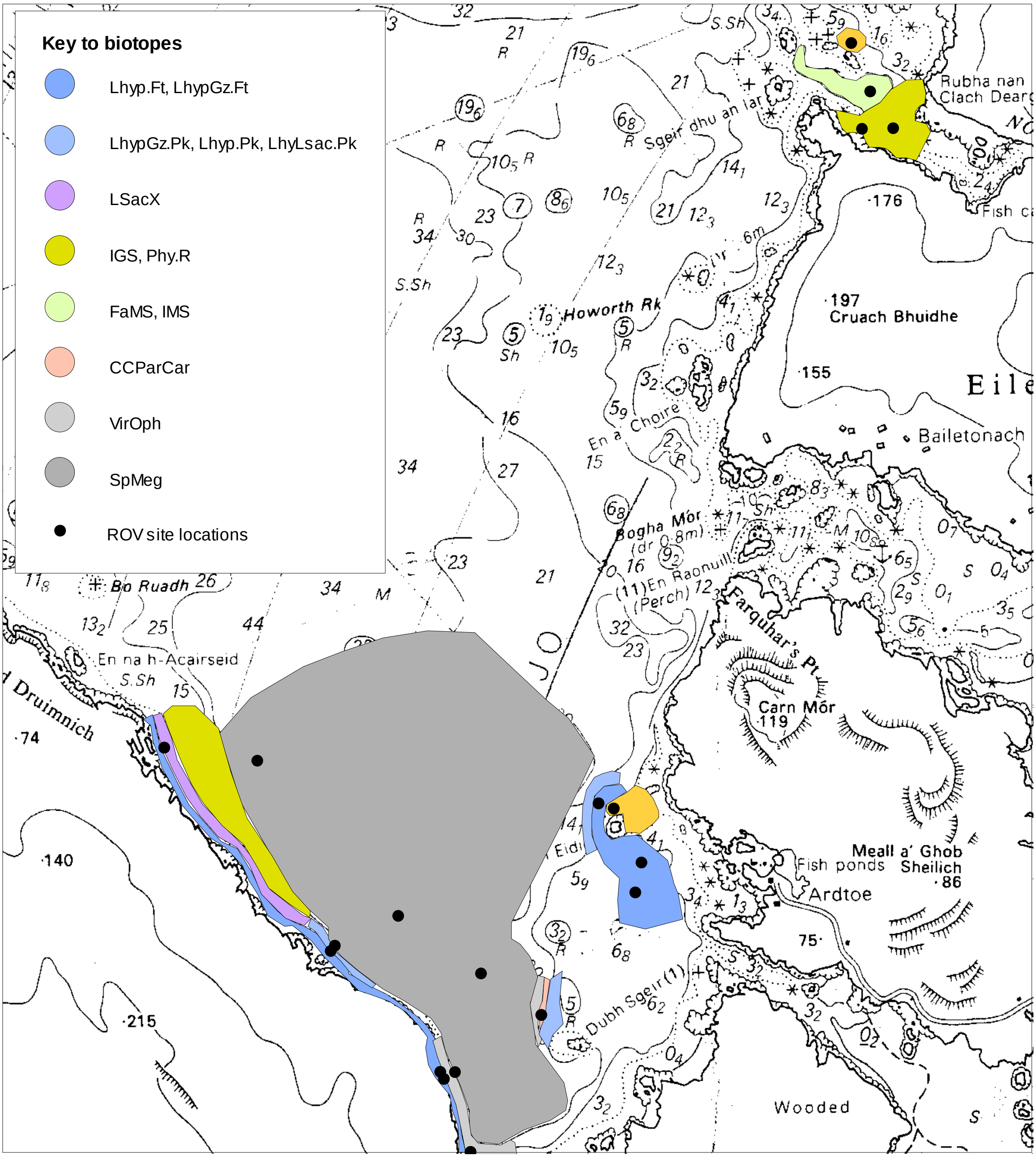

Figure 2. Distribution of biotopes in the Sound of Arisaig based on ROV video records. Colours based on the standard colours given in Connor *et al*. (1997), with additional colours to separate biotopes

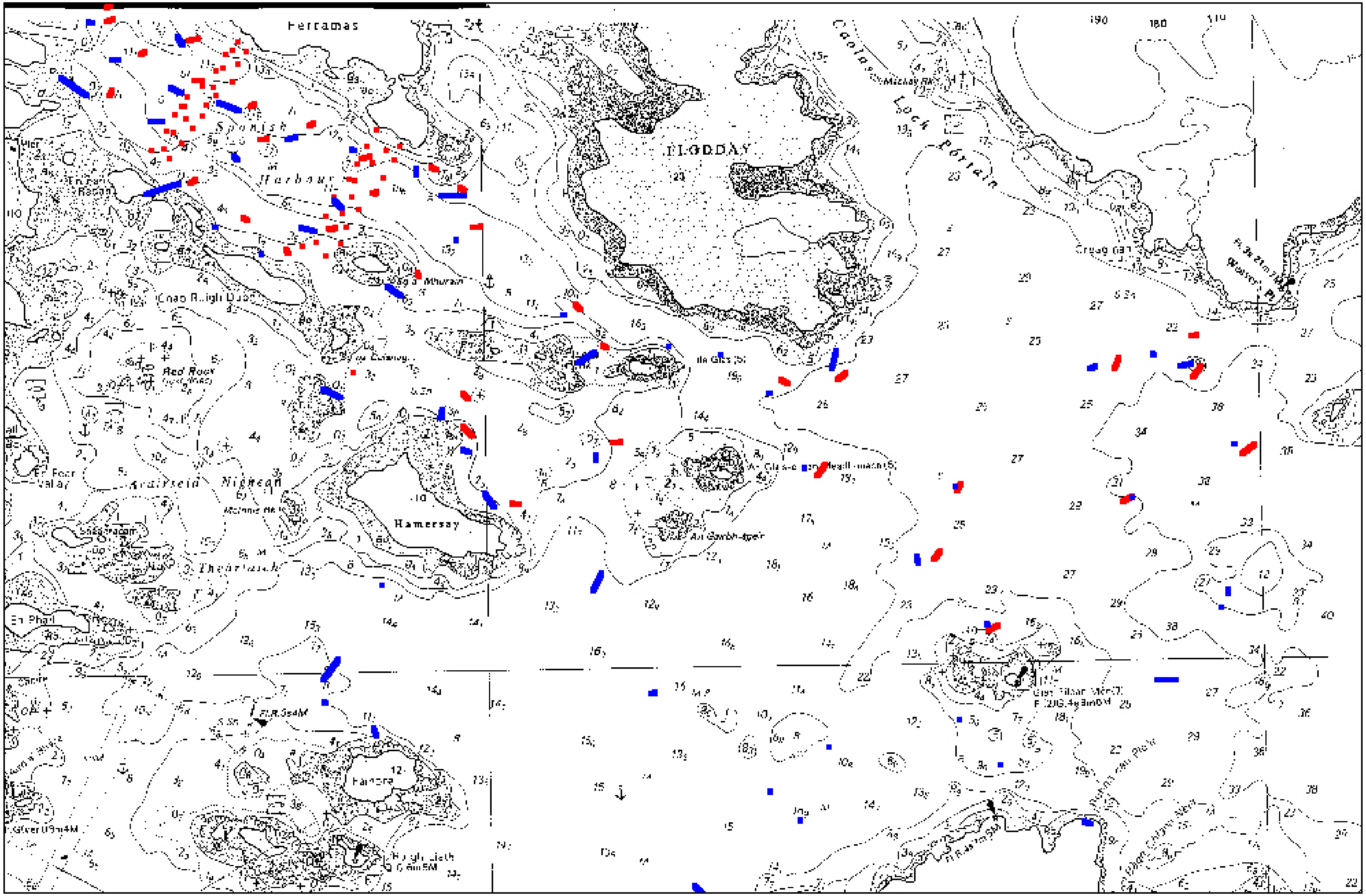

Figure 3. Locations of drop-down video survey sites in Loch Maddy. Blue=1998; Red=1999

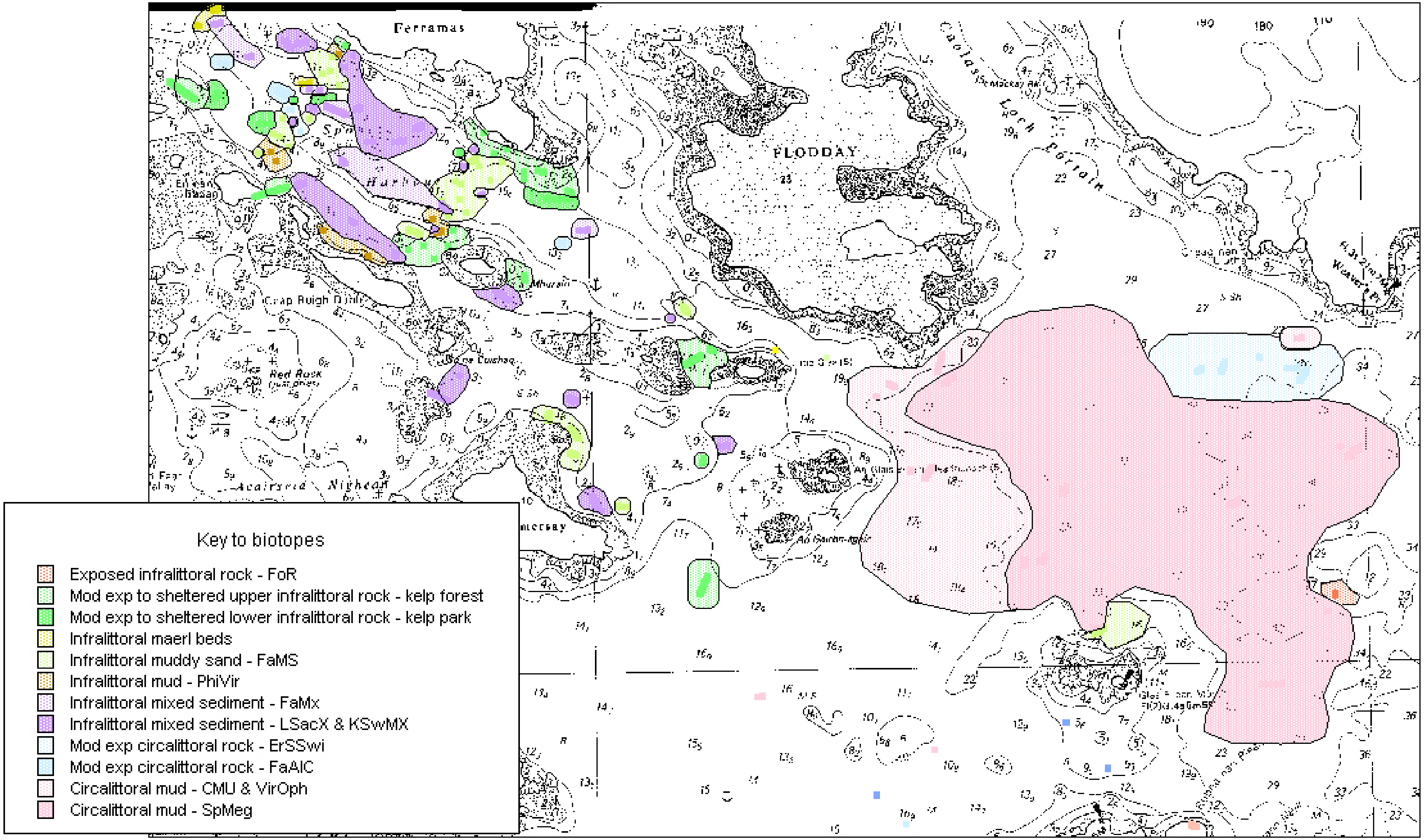

Figure 4. Distribution of biotopes in Loch Maddy based on drop-down video records. Colours based on the standard colours given in Connor *et al*. (1997), with pattern fills to separate biotopes/biotope groups

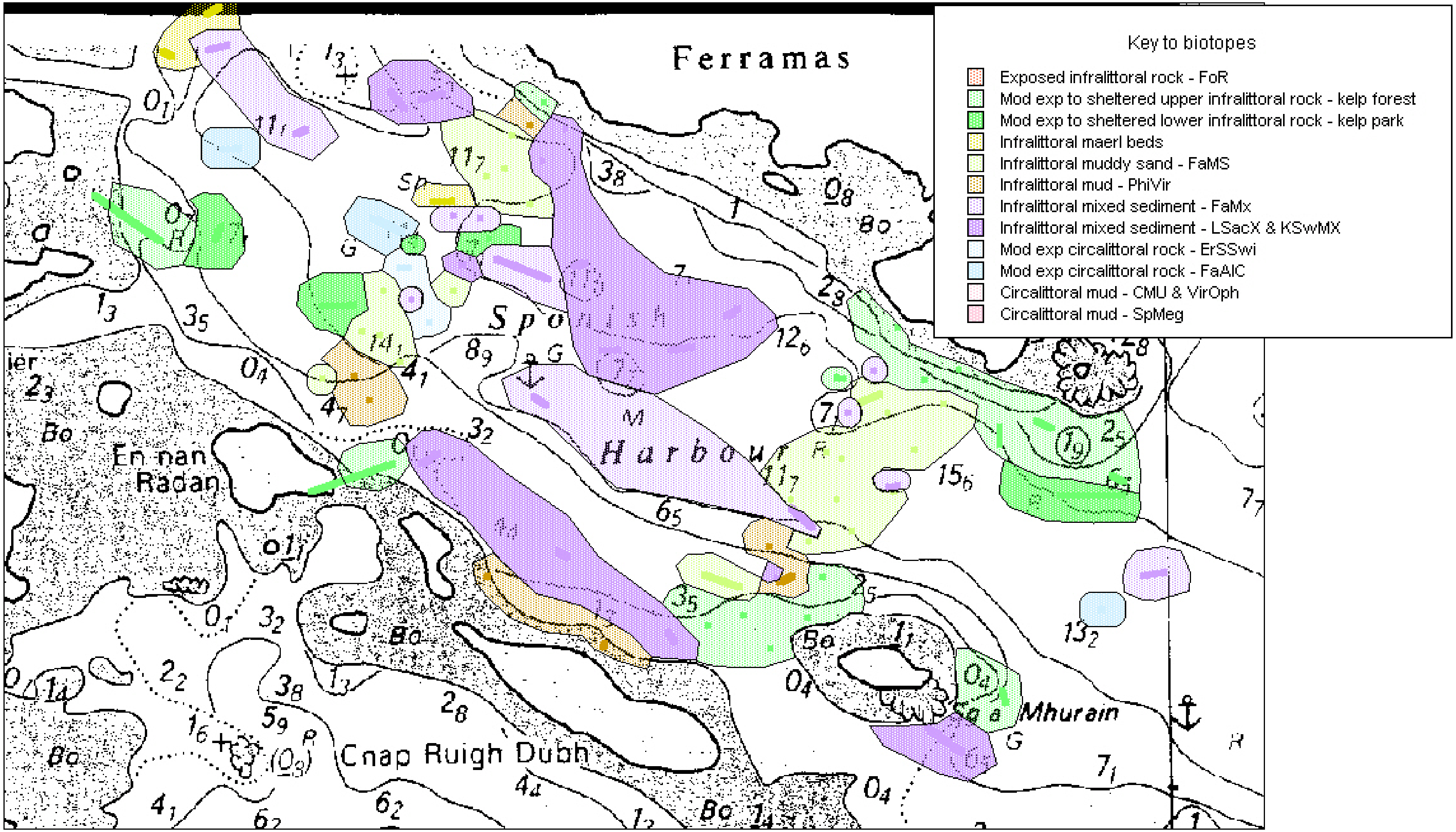

Figure 5. Distribution of biotopes in Sponish Harbour based on drop-down video records. Colours based on the standard colours given in Connor *et al*. (1997), with pattern fills to separate biotopes/biotope groups

Appendix 1. Reassessment of video from Sound of Arisaig

List of biotopes present at nine ROV dive sites in the Arisaig area (determined by F. Bunker). Biotopes are coded according to Connor *et al.* 1997. Assignment of **Tag** and **Fit** codes follow those listed in Connor *et al*. (1997) (section 3.3 'Matching data to the classification'), where **?** = Unsure if record fits defined biotope; **P** = Only part of record refers to the identified biotope (i.e. record includes several biotopes); **I** = Incomplete record lacking full species list (such as collected in rapid surveys and video surveys; phase 1 methodology); **?P** = Combination of ? and P above. Abundances in brackets refer to MNCR abundance scales (Hiscock, K., ed. (1996) with the addition of P = Present where abundance cannot be determined.

Site No	**Habitat(s)**	**Depth (from ROV)**	**Dominant Biotope(s) and % cover**	**Tag**	**Fit**	**Subordinate Biotope(s) and % cover**	**Dominant species / abundance**	**Notes**
1a	Mixed substrata of shell and fine sediments	10.3m to 12.1m	CMS.VirOph (75%)	P, I	Moderate	LsacX (25%)	Laminaria saccharina C Filamentous red algae F Virgularia mirabilis F Asterias rubens F Pecten maximus C	Not a true circalittoral biotope.
1b	As above	As above	As above	As above	As above	As above	As above	As above
2	Mud and shell fragments	19.7m	CMU.SpMeg (100%)	I	High		Nephrops burrows A Virgularia mirabilis F Arenicola marina C	
3	Muddy shell sediment with shell and pebbles	10.8m	CMS.VirOph (75%)	P, I	Moderate	LsacX (25%)	Laminaria saccharina C Foliose red algae (including ?Polyides and Furcellaria) C Virgularia mirabilis F Asterias rubens F	Not a true circalittoral biotope.
	Muddy shell sediment, shell, pebble and cobble	9.8m	LsacX (100%)	I	Moderate		Laminaria saccharina (C) Desmarestia sp. (O) Foliose red algae (C) Pomatoceros sp. (C) Crustose Corallinaceae (F)	A narrow transition zone and it is debatable whether it should be recorded as a separate 'dominant' biotope

Site No	**Habitat(s)**	**Depth (from ROV)**	**Dominant Biotope(s) and % cover**	**Tag**	**Fit**	**Subordinate Biotope(s) and % cover**	**Dominant species / abundance**	**Notes**
	Small boulders	7m	LsacSac	P, I	High		Crustose Corallinaceae (A) Non calcareous crusts (C) Laminaria saccharina (A) Laminaria hyperborea (C) Saccorhiza polyschides (C) Membranipora membranacea (C) Spirorbis sp. F	Laminaria hyperborea not characteristic of this biotope
4	Mixed substsrata, predominantly fine sand, shell gravel and pebble	9.5m	LsacX (100%)	I	High		Laminaria saccharina (C) Laminaria hyperborea (F) Foliose red algae (including ?Polyides and Furcellaria) (C) Pomatoceros sp. (O)	Laminaria hyperborea not characteristic of this biotope
	Small boulders, cobble and sediment	8.3m	LsacSac	P, I			Crustose Corallinaceae (F) Non calcareous crusts (O) Laminaria saccharina (A) Laminaria hyperborea (A) Spirorbis sp. F Echinus esculentus (C)	Laminaria hyperborea not characteristic of this biotope
	Fine sand and mud with shell fragments, whole shells and some pebbles	11.8m to 15.8m	VirOph	P, 1	Moderate		Foliose red algae (F) Virgularia (F) Cerianthus (P) Arenicola (F) Chaetopterus (P)	Not a true circalittoral biotope
5	Bedrock	8m to 10.4m	LhypGz.Pk	I	High		Laminaria hyperborea (C) Crustose Corallinaceae (A) Non calcareous crusts (F) Foliose red algae (F) Membranipora membranacea (C) Echinus esculentus (C) Antedon bifida (C)	In between kelp park and kelp forest
	Coarse shell sand waves with shell gravel in troughs	10.8m	IGS	I	Low			Not enough information to be able to allocate to biotope

Site No	Habitat(s)	Depth (from ROV)	Dominant Biotope(s) and % cover	Tag	Fit	Subordinate Biotope(s) and % cover	Dominant species / abundance	Notes
	Coarse shell sand with boulder and cobble	10.3m	LsacX	I	Low		Laminaria saccharina (A) Spirorbis (C) Membranipora membranacea (F)	A disturbed zone between shallow rock and deeper sediments. Clean sediments and scoured kelp make this atypical of the biotope.
	Fine muddy sand and shell	14.5	Phy.HEc	I?	Low		Maerl (species unknown) F Pomatoceros triqueter (F) Cerianthus lloydii (P)	Unsure if maerl alive or dead.
	Low lying bedrock	13.8	CCParCar	I?	Low		Crustose Corallinaceae (A) Non-calcareous crusts (C) *Echinus* (C) *Crossaster papposus* (P)	Corynactis, sponges and Caryophyllia not seen in video.
	Bedrock	5m	LhyppGz..Ft	I?			*Laminaria hyperborean* *Echinus* (C) Crustose Corallinaceae *Membranipora membranacea* *Ascidiella aspersa* *Antedon bifida*	
6	Bedrock	8.0m to 12.5m	LhypGz.Pk	I	High		*Laminaria hyperborea* (C) Foliose red algae (O) Delesseria sanguinea (P) Crustose Corallinaceae (F) Non-calcareous crusts (C) *Balanus balanus* (F) Unidentified white fuzz (A)	At beginning seabed looks like kelp park from 2.3m to 12.1m.

Site No	**Habitat(s)**	**Depth (from ROV)**	**Dominant Biotope(s) and % cover**	**Tag**	**Fit**	**Subordinate Biotope(s) and % cover**	**Dominant species / abundance**	**Notes**
	Bedrock and boulders	12.5m to 14.2m	CCParCar	I	Low		Crustose Corallinaceae (A) Non-calcareous crusts (F) Foliose red algae (R) *Laminaria hyperborea* (O) *Balanus balanus* (P) *Pomatoceros* sp (C) *Asterias rubens* (P) *Marthasteria glacialis* (P) *Echinus esculentus* (A) *Ascidia mentula* (F)	
	Rippled sand with cobbles, pebbles and shell + maerl fragments	14.5m to 15.0m	IGS	I	Low		Maerl (R) Foliose red algae (O) *Pecten maximus* (P) *Pomatoceros* sp (P)	Not certain if maerl is alive or dead. Probably a lot more algae in summer. Only a small area surveyed. Impossible to be more precise.
	Bedrock	2.0m to 8.0m	LhyppGz..Ft		High		*Laminaria hyperborea* (A+) Foliose red algae (O) Delesseria sanguinea (P) Crustose Corallinaceae (F) Non-calcareous crusts (C) *Balanus balanus* (F) Unidentified white fuzz (A)	Definite kelp forest Shown at end of video tape.
7	Sandy sediment in waves with shell fragments	10.3m	IGS	I	Low		Foliose red algae (C) Paguriidae indet. (P) Gobiidae (F)	Sediment looked silty Not enough species visible to tie into a biotope. Empty razor shells on the sediment surface.

Site No	**Habitat(s)**	**Depth (from ROV)**	**Dominant Biotope(s) and % cover**	**Tag**	**Fit**	**Subordinate Biotope(s) and % cover**	**Dominant species / abundance**	**Notes**
8	Silty shell sediment with algal mats	5.8m to 6.0m	IGS	I	Low		Foliose red algae (including ?Trailiella mats) (F) Chaetopterus variopedatus Carcinus maenas (P)	Many empty razor shells noted on the sediment surface. Border-line between IGS and IMS
9	Muddy shell sediment	18.2m	IMS	I	Low		Foliose red algae (F) Drift kelp Liocarcinus sp. (P)	Very dark and murky and could not enough area to categorise any further.

Appendix 2. Reassessment of video from Loch Maddy

List of biotopes present at drop-down video sites in Loch Maddy (determined by F. Bunker). Biotopes are coded according to Connor *et al.* 1997. Assignment of **Tag** and **Fit** codes follow those listed in Connor *et al*. (1997) (section 3.3 'Matching data to the classification'), where **?** = Unsure if record fits defined biotope; **P** = Only part of record refers to the identified biotope (i.e. record includes several biotopes); **I** = Incomplete record lacking full species list (such as collected in rapid surveys and video surveys; phase 1 methodology); **?P** = Combination of ? and P above. Abundances in brackets refer to MNCR abundance scales (Hiscock, K., ed. (1996) with the addition of P=present where abundance cannot be determined.

Site No	**Habitat(s)**	**Depth (from report)**	**Dominant Biotope(s) and % cover**	**Tag**	**Fit**	**Subordinate Biotope(s) and % cover**	**Dominant species / abundance**	**Notes**
1	Fine sediment with shell fragments		IMS (100%)	?	Low		?Trailiella P Drift algae	Pea green image not very clear. Unclear is algae is living. May even be patches of dark pebbles.
2	Mixed substrata, mainly cobbles and pebbles with bedrock outcrops		IMX (100%)	?	Low	LhypLsac.Ft	Laminaria saccharina P Laminaria hyperborea C Red foliose algae F Obelia geniculata O Nemertesia antennina P Echinus esculentus P	Can't really distinguish features on the mixed substrata
3	Mixed substrata, mainly cobbles and pebbles		IMX (100%)	?	Low		Laminaria saccharina P Foliose red algae C Cancer pagurus P	Doesn't cover a wide area. Similar substrata to dive 2 but no rock. Only one or two kelp plants seen.
4	Boulders on silty sediments		IMX.LsacX(100 %)	I	Moderate		Laminaria saccharina A Foliose red algae P ?Trailiella P Spirorbidae indet. (on kelp) P	Can't distinguish many species from the video
5	Boulders on silty sediments		IMX (70%)	I	Moderate	SIR Lsac X(30%)	Laminaria saccharina P Foliose red algae P Small gadoids P Nemertesia antennina P	Very murky shots and don't cover a wide area

Site No	**Habitat(s)**	**Depth (from report)**	**Dominant Biotope(s) and % cover**	**Tag**	**Fit**	**Subordinate Biotope(s) and % cover**	**Dominant species / abundance**	**Notes**
6	Mixed substrata mainly cobbles and pebbles with barren gravel patches		IMX (80%)	I	Moderate		Foliose red algae P Echinus esculentus *P*	Pretty barren substrata. Some drift seaweed present. Difficult to determine even the % cover of seaweed.
7	Silty pebbles and gravel with fine sediments. Some boulders		IMX (95%)	I	Moderate	SIR.Lsac (5%)	Foliose red algae P *Echinus esculentus* P Laminaria saccharina *P*	More silty than other sites studied.
8	Boulders and cobble on fine silty (shell?) sediment		IMX.LsacX (100%)	I	Moderate		Laminaria saccharina *A* Laminaria hyperborea *R* Foliose red algae C Encrusting bryozoa (on kelp) P Ascidiacea indet. (on kelp) P	
9	Silty pebbles and gravel with fine sediments		IMX (100%)	I	Moderate		Laminaria saccharina P Foliose red algae C Small gadoids P	No signs of kelp other than one or two plants
10	Silty cobbles pebbles and gravel with fine sediments		IMX (100%)	I	Moderate		Laminaria saccharina *P* Foliose red algae F Hydroid indet. P	No signs of kelp other than one or two plants

Appendix 3. Site data from Arisaig 1998 imported into MapInfo database

Site	Dive type	Latitude	Longitude	Biotope 1	Biotope 2	Biotope 3	Biotope 4	Colour	Group
1a	Free, with 1b	56.7542	-5.9123	VirOph				T	13
1b	Transect	56.7542	-5.9123	VirOph				T	13
2	Spot	56.7585	-5.9138	SpMeg				T	12
3	Transect, with 4	56.7585	-5.9153	LsacSac	LsacX	VirOph		H	1
4	Free	56.7581	-5.9149	LsacSac	LsacX	VirOph		H	1
5	Transect, with 6	56.7730	-5.8993	LhypGz.Ft	Phy	CCParCor,	LsacX	I	1
6	Free	56.7730	-5.8993	LhypGz.Ft	LhypGz.Pk	CCParCar	IGS	I	1
7	Spot	56.8095	-5.8726	IGS				K	3
8	Spot	56.8095	-5.8695	IGS				K	3
9	Spot	56.8115	-5.8718	IMS				L	5
10	Transect	56.8142	-5.8736	Phy.R				K	3
11	Free, with 12	56.7727	-5.8978	Phy.R	LhypGz.Ft			K	3
12	Transect	56.7727	-5.8978	Phy.R	LhypGz.Ft			K	3
13	Free, with 14	56.7651	-5.9261	LhypGz.Pk	LsacX	SpMeg	VirOph	I	2
14	Transect	56.7654	-5.9257	SpMeg	VirOph			T	12
15	Spot	56.7670	-5.9194	SpMeg				T	12
16	Spot	56.7638	-5.9112	SpMeg				T	12
17	Free, with 18	56.7616	-5.9052	LhypLsac.Pk	VirOph			J	2
18	Transect	56.7616	-5.9052	CCParCar	VirOph			O	9
19	Transect, with 20	56.7762	-5.9426	IGS	FaMX			K	3
20	Free	56.7762	-5.9426	IGS	LSacX			K	3
21	Spot	56.7754	-5.9333	SpMeg				T	12
22	Spot	56.7698	-5.8951	Lhyp.Ft				I	1
23	Spot	56.7682	-5.8957	Lhyp.Ft	Phy			I	1

Appendix 4. Site data from Loch Maddy 1998 and 1999 imported into MapInfo database (data provided by SeaMap)

1998 data

Site	Longitude In	Latitude In	Longitude Out	Latitude Out	Biotope 1	Biotope 2	Biotope 3	Colour	Group
101	-7.150100	57.615164	-7.149967	57.615117	Lgla			K	8
102	-7.148300	57.616047	-7.148217	57.616000	Lgla			K	8
103	-7.149133	57.614267	-7.148867	57.614267	FaAlC	Lgla		P	18
104	-7.146300	57.614767	-7.146050	57.614600	LsacX			N	14
105	-7.146633	57.613614	-7.146150	57.613483	FaAlC			P	18
106	-7.147533	57.612833	-7.146983	57.612833	Lsac.Pk			J	4
107	-7.147750	57.611150	-7.146367	57.611386	Lsac.Ft			J	3
108	-7.143967	57.611983	-7.143767	57.611900	FaMx			N	13
109	-7.141650	57.612367	-7.141300	57.612403	LsacX			N	14
110	-7.138867	57.612100	-7.138767	57.612086	Lsac.Ft			J	3
111	-7.139683	57.610933	-7.139317	57.610750	FaMx			N	13
112	-7.144817	57.610353	-7.144800	57.610353	PhiVir			M	11
113	-7.141150	57.610336	-7.140550	57.610217	FaMS			L	10
114	-7.136133	57.611633	-7.136133	57.611467	LhypLsac.Ft			J	3
115	-7.135117	57.610997	-7.134083	57.610983	Lsac.Pk			J	4
116	-7.137450	57.608914	-7.136850	57.608683	LsacX			N	14
117	-7.140283	57.606567	-7.139550	57.606367	LsacX			N	14
118	-7.142883	57.609700	-7.142850	57.609733	MarMu			M	11
119	-7.144550	57.613233	-7.143683	57.613033	FaMx			N	13
120	-7.150633	57.616381	-7.150283	57.616317	LsacX	FaS		N	14
121	-7.150700	57.616517	-7.150083	57.615869	LhypLsac.Ft	FaS		J	3
122	-7.150217	57.613436	-7.151317	57.613867	LhypLsac.Ft	LhypLsac.Pk		J	3
447	-7.138267	57.598536	-7.138367	57.598697	VirOph			T	23
448	-7.107317	57.606733	-7.107050	57.606817	ErsSwi	SpMeg		P	17
449	-7.103433	57.606783	-7.102950	57.606817	ErsSwi			P	17
450	-7.123200	57.607200	-7.123200	57.607205	CMS			S	20
451	-7.125417	57.607417	-7.125417	57.607412	CGS			R	19
452	-7.137930	57.602000	-7.137930	57.602005	LSacX			N	14
453	-7.139100	57.593900	-7.139100	57.593905	VirOph			T	23
454	-7.139570	57.592600	-7.139570	57.592605	VirOph			T	23
455	-7.130730	57.591300	-7.130730	57.591305	VirOph			T	23
456	-7.120120	57.596400	-7.120120	57.596405	FaAlC			P	18
457	-7.118830	57.598100	-7.118830	57.598105	VirOph			T	23
458	-7.111420	57.597600	-7.111420	57.597605	Lhyp.Ft			I	3
459	-7.135267	57.605950	-7.135200	57.606033	FaMS			L	10
460	-7.134350	57.605103	-7.134050	57.605050	FaMS			L	10
461	-7.135283	57.605867	-7.135183	57.605883	FaMS	LhypLsac.Ft		L	10
462	-7.133417	57.604086	-7.133033	57.603767	LsacX	FaMx		N	14
463	-7.129900	57.608183	-7.129883	57.608183	FaMx			N	13
464	-7.129317	57.607083	-7.128600	57.607333	LhypLsac.Ft	Lsac.Pk		J	3
465	-7.134500	57.609950	-7.134450	57.609969	FaAlC			P	18
501	-7.155450	57.617867	-7.155383	57.617814	Lhyp.TPk			I	4
502	-7.157817	57.616064	-7.158083	57.616017	LsacX			N	14
503	-7.161833	57.617917	-7.161450	57.617683	Lgla			K	8
504	-7.163833	57.617303	-7.164050	57.617150	Ldig.Ldig			I	5

Site	Longitude In	Latitude In	Longitude Out	Latitude Out	Biotope 1	Biotope 2	Biotope 3	Colour	Group
505	-7.163200	57.619003	-7.163367	57.619050	Lhyp.TFt			I	3
506	-7.160467	57.620450	-7.160383	57.620403	Lsac.Ft	LhypLsac		J	3
507	-7.162150	57.620403	-7.162450	57.620517	Lgla	Lhyp.TPk		K	8
508	-7.163033	57.620450	-7.162767	57.620500	Lgla	Lhyp.Pk		K	8
509	-7.161767	57.622153	-7.161683	57.622183	Lsac.Ft			J	3
510	-7.163642	57.620197	-7.163467	57.620133	Lgla			K	8
511	-7.165300	57.618600	-7.165633	57.618350	HalXK			I	6
512	-7.169283	57.617619	-7.169600	57.617733	LsacX			N	14
513	-7.170500	57.619164	-7.170217	57.619250	LsacX			N	14
514	-7.169050	57.619667	-7.169183	57.619686	HalXK			I	6
515	-7.166950	57.620467	-7.167233	57.620300	LsacX			N	14
516	-7.167133	57.623250	-7.167217	57.623383	Phy.R	Lhyp.Ft		K	9
517	-7.178833	57.624747	-7.178733	57.624747	Lgla			K	8
518	-7.182467	57.625550	-7.182400	57.625533	Lsac			J	3
519	-7.182617	57.625467	-7.181233	57.625317	LsacRS			J	3
521	-7.185433	57.629017	-7.184700	57.629086	AreSyn			M	12
522	-7.180733	57.626100	-7.180681	57.626039	LhypLsac.Ft			J	3
523	-7.177733	57.625269	-7.177900	57.625200	Lhyp.Ft			I	3
524	-7.176533	57.626797	-7.176867	57.626700	LhypLsac.Ft	Phy.R		J	3
525	-7.175783	57.626797	-7.175583	57.626383	Phy			K	8
526	-7.171567	57.624433	-7.171517	57.624483	LhypGz.Ft			I	3
527	-7.172950	57.622503	-7.173267	57.622533	HalXK			I	6
528	-7.168850	57.622686	-7.169817	57.622783	Lhyp.Ft			I	3
529	-7.161750	57.620633	-7.161583	57.620817	Lgla			K	8
566	-7.101833	57.601167	-7.101833	57.601167	SpMeg			T	22
567	-7.101500	57.601500	-7.101517	57.601567	FoR	Xfa		H	2
568	-7.111900	57.600867	-7.111850	57.600850	SpMeg			T	22
569	-7.110900	57.616017	-7.111850	57.616017	LhypGz.Ft			I	3
570	-7.113167	57.598667	-7.113150	57.598667	LhypGz.Pk			I	4
571	-7.114867	57.602467	-7.114833	57.602317	SpMeg			T	22
572	-7.113183	57.604083	-7.113183	57.604067	SpMeg			T	22
573	-7.105567	57.603733	-7.105567	57.603739	SpMeg			T	22
574	-7.104667	57.599500	-7.103800	57.599517	SpMeg			T	22
575	-7.107867	57.596283	-7.107617	57.596217	AlcMaS	SpMeg		O	16
576	-7.107633	57.594550	-7.107567	57.594467	LhypGz.Ft	CGS	LhypGz.Pk	I	3
577	-7.101167	57.604950	-7.101133	57.604950	SpMeg			T	22
578	-7.104583	57.607083	-7.104550	57.607050	ErSSwi	FaAlC	SpMeg	P	17
579	-7.119683	57.604583	-7.119667	57.604533	SpMeg			T	22
580	-7.126433	57.599383	-7.126233	57.599433	SpMeg			T	22
781	-7.139850	57.600317	-7.140533	57.599850	VirOph			T	23
782	-7.140433	57.599300	-7.140483	57.599333	LhypLsac.Ft	VirOph		J	3
783	-7.121083	57.606314	-7.121117	57.606300	CMU			T	21
784	-7.118233	57.607250	-7.118433	57.606831	CMU			T	21
785	-7.128483	57.602217	-7.128833	57.601797	LhypLsac			J	3
786	-7.128600	57.604947	-7.128617	57.604817	LhypLsac.Ft			J	3
887	-7.121350	57.597050	-7.121350	57.597090	LhypGz.Ft			I	3
888	-7.124667	57.594950	-7.121300	57.593017	CMU			T	21

1999 data

Site	Easting In	Northing In	Easting Out	Northing Out	Biotope 1	Biotope 2	Biotope 3	Colour	Group
1	92736.21	870076.71	92738.3	870073.42	FaMS			L	10
2	92593.71	870008.42	92573.94	870004.89	FaMx	Lhyp.Pk		N	13
3	92664.89	869916.71	92654.04	869912.17	FaMx			N	13
4	92570.75	869826.62	92562.59	869813.95	LhypLsac.Pk	Lsac.Ft		J	4
5	92754.71	869767.91	92746.35	869767.66	ErSSwi	FaMS		P	17
6	92804.74	869831.84	92785.45	869832.08	Phy.R			K	9
7	92805.23	869939.23	92781.58	869935.1	LsacX			N	14
8	92931.99	869756.33	92920.89	869753.16	LsacX	Lsac.Ft		N	14
9	93080.49	869695.98	93069.01	869689.36	LsacX			N	14
10	92956.28	869666.3	92940.24	869665.95	LsacX			N	14
11	92766.12	869578.04	92749.39	869568.69	LsacX	Lsac.Ft		N	14
12	92877.64	869469.18	92887.05	869461.08	KSwMX			N	14
13	92980.84	869377.83	92985.47	869365.97	LsacX	Lsac.Ft		N	14
14	93224.18	869503.43	93215.73	869501.95	FaMx			N	13
15	93110.84	869421.94	93096.73	869416.19	PhiVir	Lsac.Pk		M	11
16	93483.42	869390.64	93462.51	869389.43	FaMx			N	13
17	93385.1	869546.42	93370.57	869555.02	LhypLsac.Ft	Lsac.Ft		J	3
18	93452.18	869485.78	93440.59	869493.48	LhypLsac.Ft	Lsac.Ft		J	3
19	93312.29	869274.07	93310.77	869287.27	LhypLsac.Ft	Lsac.Ft		J	3
20	93721.12	869151.85	93708.57	869168.34	FaMS			L	10
21	93778.56	869045.34	93768.26	869055.05	LhypLsac.Ft			J	3
22	94234.56	868911.77	94218.67	868923.81	CMU			T	21
23	93791.36	868803.38	93768.96	868802.28	LsacX	Lsac.Ft		N	14
24	93516.8	868668.05	93499.25	868672.5	FaMS	LsacX		L	10
25	93412.94	868854.76	93390.82	868881.92	FaMS	LsacX		L	10
26	93411.41	868950.78	93397.36	868963.36	LsacX			N	14
27	93120.9	869043.37	93120.9	869043.37	LsacX	Lsac.Ft		N	14
28	95294.53	868858.96	95271.38	868832.77	ErSSwi			P	17
29	95291.22	868943.94	95277.61	868940.05	CMU			T	21
30	95087.06	868899.43	95073.96	868873.71	ErSSwi			P	17
31	95412.59	868647.98	95379.42	868625.67	SpMeg			T	22
32	95088.2	868543.24	95063.94	868528.65	SpMeg			T	22
33	94714.36	868243.31	94689.03	868229.68	FaMS			L	10
34	94582.6	868445.17	94564.5	868426.31	SpMeg			T	22
35	94651.96	868614.97	94641.08	868597.24	SpMeg			T	22
36	94308.98	868697.12	94286.53	868669.32	VirOph	FaMS		T	23
37	94384.43	868925.24	94361.09	868910.25	SpMeg			T	22
38	93215.96	869596.6	93193.62	869589.91	FaMS	LsacX		L	10
39	92589.04	870047.22	92576.24	870041.38	Mrl			K	8
T1	92702.38	869637.54	92702.38	869637.54	PhiVir	FaMS		M	11
T2	92736.51	869673.84	92736.51	869673.84	FaMS			L	10
T3	92770.72	869710.25	92770.72	869710.25	ErSSwi	FaMS		P	17
T4	92797.05	869740.22	92797.05	869740.22	FaMS	Lsac.Pk		L	10
T5	92837.36	869789.01	92837.36	869789.01	LhypLsac.Pk	FaMS		J	4
T6	92881.99	869819.83	92881.99	869819.83	FaMS			L	10
T7	92899.28	869862.66	92899.28	869862.66	LsacX	Phy.R	FaMS	N	14
T8	92925.3	869892.43	92925.3	869892.43	LsacX	Lsac.Ft		N	14
T9	92889.22	869899.08	92889.22	869899.08	PhiVir	FaMx		M	11

Site	Easting In	Northing In	Easting Out	Northing Out	Biotope 1	Biotope 2	Biotope 3	Colour	Group
T10	92860.33	869858.35	92860.33	869858.35	FaMS	FaMx		L	10
T11	92830.61	869810.77	92830.61	869810.77	FaMx			N	13
T12	92808.67	869765.26	92808.67	869765.26	LsacX	FaMS		N	14
T13	92753.89	869735.11	92753.89	869735.11	FaMx	FaMS		N	13
T14	92718.52	869702.26	92718.52	869702.26	FaMS			L	10
T15	92689.25	869663.69	92689.25	869663.69	PhiVir			M	11
T16	92657.57	869663.64	92657.57	869663.64	FaMS			L	10
T17	92701.12	869707.83	92701.12	869707.83	FaMS			L	10
T18	92727.21	869747.1	92727.21	869747.1	FaMS			L	10
T19	92762.94	869790.87	92762.94	869790.87	Lsac.Pk	FaMS		J	4
T20	92803.81	869815.6	92803.81	869815.6	FaMx			N	13
T21	92841.52	869852.42	92841.52	869852.42	FaMS			L	10
T22	92870.87	869891.32	92870.87	869891.32	FaMS			L	10
T23	92906.28	869920.71	92906.28	869920.71	Lsac.Ft	LsacX		J	3
T24	93020.68	869379.38	93020.68	869379.38	Lsac.Ft	LsacX		J	3
T25	93056.18	869417.04	93056.18	869417.04	FaMS			L	10
T26	93089.41	869453.3	93089.41	869453.3	PhiVir			M	11
T27	93116.12	869498.56	93116.12	869498.56	FaMS			L	10
T28	93156.77	869542.42	93156.77	869542.42	FaMS	FaMx		L	10
T29	93181.11	869580.13	93181.11	869580.13	FaMx	FaMS		N	13
T30	93211.78	869620.61	93211.78	869620.61	FaMx	FaMS		N	13
T31	93240	869661.17	93240	869661.17	Lsac.Ft			J	3
T32	93261.13	869606.81	93261.13	869606.81	Lsac.Ft			J	3
T33	93221.2	869577.09	93221.2	869577.09	FaMS			L	10
T34	93170.43	869535.12	93170.43	869535.12	FaMS			L	10
T35	93161.68	869494.98	93161.68	869494.98	FaMS			L	10
T36	93130.62	869454.87	93130.62	869454.87	FaMS	MarMu		L	10
T37	93094.35	869421.29	93094.35	869421.29	LsacX	FaMS		N	14
T38	93058.09	869386.94	93058.09	869386.94	Lsac.Ft			J	3
T39	93081.32	869350.75	93081.32	869350.75	Lsac.Ft			J	3
T40	93121.38	869379	93121.38	869379	Lsac.Ft	LsacX		J	3
T41	93140.41	869417.91	93140.41	869417.91	Lsac.Ft			J	3
T42	93174.6	869461.14	93174.6	869461.14	FaMS			L	10
T43	93219.72	869496.84	93219.72	869496.84	FaMS	FaMx		L	10
T44	93244.69	869537.3	93244.69	869537.3	FaMS	FaMx		L	10
T45	93278.91	869581.09	93278.91	869581.09	FaMS	FaMx		L	10
T46	93297.29	869613.78	93297.29	869613.78	Lsac.Ft			J	3

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REPORT DISTRIBUTION

Report number	369
Date received	August 2001
Report title	**Development of methods for monitoring subtidal biotope extent using remote video: A Report for the UK Marine SACs Project**
Contract title	Development of methods for monitoring subtidal biotope extent using remote video
Contractor	Cordah Limited, Ti Cara, Point Lane, Cosheston, Pembroke Dock, Pembrokeshire, SA72 4UN

Comments

Task 3.2 of the UK marine Special Areas of Conservation project was to identify and develop appropriate methods for recording, monitoring and reporting natural characteristics of Annex I/II features, and relevant environmental factors. The JNCC revised the 1996 version of ‘Biological monitoring of marine Special Areas of Conservation: a handbook of methods for detecting change’ to incorporate the recent learning and current relevant information from monitoring trials, compiled in the last two years into a 2001 version ‘The Marine Monitoring Handbook’. Part 2 of this handbook is a compendium of descriptions of the appropriate techniques for monitoring the condition of features on SAC’s.

This report describes an assessment of the use of remote video, collected by ROV, towed sledge or drop-down video methods, to monitor seabed biotope extent in a marine SAC. The first stage of the project was to examine remote video footage collected during the Arisaig and Loch Maddy surveys, and the biotope data derived from that video footage, which was then imported into a MapInfo GIS. The biotopes maps generated by this methodology were then compared with biotope maps previously generated by AGDS. An alternative approach to the problem of monitoring biotope extent with remote video data was also suggested. This approach makes no attempt to produce maps from the data, but simply monitors the relative frequency of biotopes recorded by remote video in a defined area.

The objectives of this project were:

- To examine video footage collected during the Arisaig and Loch Maddy surveys using remote video, and the biotope data derived from that video footage, to ensure that the biotopes had been recorded consistently;
- To compile a set of biotope records from the Arisaig and Loch Maddy datasets that had been identified consistently;
- To develop guidelines for consistent biotope identification;

- To develop a methodology for generating biotope maps from the video data;
- To compare these maps with those prepared from more detailed AGDS survey data;
- To assess the use of the methods for monitoring biotope extent;
- To prepare a procedural guideline for the methodology.

Restrictions None.

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