ECOREGION General advice
SUBJECT Protocols for assessing the status of sea-pen and burrowing megafauna communities

Advice Summary

It is technically feasible to use video and photographic data collected during *Nephrops* video surveys to derive semi-quantitative abundance estimates of sea-pen and burrowing megafauna within the areas being surveyed. This is particularly the case for those species that are easily identifiable or have distinctive burrow signatures. Habitat preferences and the uncertainty regarding the spatial overlap between the coverage of *Nephrops* surveys and the species to be assessed must be considered before using these data for assessing trends or status. Considerable progress has been made on burrow identification, however, it is currently not possible to develop a complete methodology, or a set of protocols, for using the video-derived abundance data from the *Nephrops* video surveys to accurately assess the status of sea-pen and burrowing megafaunal species.

Request

Protocols for assessing the status of sea-pen and burrowing megafauna communities

To evaluate whether ecological data from commercial Nephrops stock assessment and commercial video and photographic footage could be used for assessment of the status of sea-pen and burrowing megafauna communities, and were [where] possible, develop protocols for the use of this information[1].

ICES Advice

Survey design, in particular the location where observations are collected, will have a significant influence on the number of sea-pen and burrowing megafauna recorded by video and photographic footage. Based on a comparison between diver observations and *Nephrops* video surveys around Scotland, there is evidence to suggest that the 3 species of sea-pen occurring in European waters have different water depth and sediment type preference and therefore geographical distribution from each other and from *Nephrops*. The relative importance of sediment type and water depth varies between species. Habitat preference of other burrowing megafauna will also have a significant influence on numbers of these megafauna recorded in *Nephrops* surveys. In conclusion, surveys designed for covering *Nephrops* habitats are unlikely to cover the full habitats of all 3 sea-pen species. For other burrowing megafauna it will depend on the species concerned.

Further information is required to establish the extent of overlap between areas where *Nephrops* are fished commercially, i.e. where *Nephrops* video surveys take place, and the suitability of these areas for various sea-pen species and other burrowing megafauna. This is needed to inform the selection of candidate species for monitoring by *Nephrops* video surveys. Within the areas surveyed it should be possible to infer some information on the status of sea-pen and other identifiable species. Further research is needed to establish a better understanding of the relationship between local densities and overall status, in particular as sampling would be carried out in areas impacted by *Nephrops* fishing and hence potentially different from unfished areas or those exploited by fishing gear other than those used for *Nephrops*.

Examination of existing footage suggests there is a high variability in sea-pen numbers in time and space. All three sea-pen species exhibit a clustered spatial distribution which implies that a rather high sampling effort is required to observe sufficient number of individuals to obtain a reasonable precision of density estimates. Further, *Virgularia mirabilis* can retract into the sediment and *Pennatula phosphorea* partially, making it likely that counts are underestimates, in particular for the former species. Although the artificial light used during video recording does not seem to stimulate retraction, further research on this as well as the effect of cable drag and ground vibration, even from small sledges, is needed.

Once recorded, detection reliability by the observer can be problematic for reasons including poor visibility and observer inexperience and various fan-worms species may be misidentified as sea-pens. The successful discrimination of sea-pen species has been achieved in some surveys and the development of a visibility threshold could be considered for the selection of video footage for monitoring purposes. A key to guide the identification of sea bed burrows in the

[1] Commercial in this context is understood by ICES to refer to the *Nephrops* fishery. Most surveys are carried out by scientific institutes for the purpose of assessing *Nephrops* stocks that are fished commercially.

NE Atlantic and Mediterranean is provided in the Background information below and a simple guide for sea-pen identification from videos in Annex I. Further research is needed to refine and quality assure these guides prior to their incorporation into any future protocol. It should also be noted that the species discussed in the burrow identification guide do not necessarily occur in *Nephrops* grounds.

The abundance of different species can vary greatly. Scale selection is an important consideration. To avoid the introduction of different number of categories for different species monitored, a relative, rather than absolute, scale based on a modified or adapted SACFOR Scale could be used (Annex II). Information on the significance of a relative change in time and space versus the sensitivity (and practicality) of the categories chosen must be resolved before the utility of the technique can be established for status assessment.

Analysing video for multiple species is time consuming and is not a priority for surveys designed for *Nephrops* monitoring. Full quantitative analysis does not seem to be feasible during routine video analysis and experience shows that additional, dedicated, human resources are needed. Further elaboration, considering the points raised here, of the data requirements and objectives of the ecological monitoring and assessment programme (e.g. the requirements of the MSFD) is required to assist in providing more comprehensive advice.

Recommendations

Further research is needed to establish which megafaunal species (including burrowing species) can be identified using video technology and to evaluate the spatial distribution of the species to be assessed relative to spatial coverage of *Nephrops* video surveys. The burrow identification guide and the sea-pen species identification guide are useful starting points for this research. Both require quality assurance testing and calibration prior to their incorporation into a protocol. Research should also be focused on identifying burrow features that are specific to species known to coexist with *Nephrops*. Work is currently underway in the UK and Ireland on footage collected as part of the *Nephrops* surveys to establish what other species can be identified using this technology.

Background

Criteria for burrow recognition and burrow identification key

Source: ICES (2008)

The key which follows is a revision of that in Marrs *et al.* (1996) and uses surface features to identify the originator of a given burrow observed using UWTV[2], where possible to species level. This may be relatively straightforward; some burrows have species-specific features which, if visible, make their identity unmistakable. Fortunately, the larger *Nephrops* burrows are within this category. Often, however, the situation is more difficult, particularly when the overall burrow density is high, several burrow-dwelling species are common on the ground, and some of these have burrows that can be confused with those of smaller *Nephrops*. The burrows of a range of species are described in Marrs *et al.* (1996).

With experience, the observer is able to recognize the burrows of many species with a fair degree of confidence. There will, however, always be areas of uncertainty, for example, burrows which do not fully conform to the expectation for a given species, burrow recognition features which are disrupted by the passage of fishing gear, a high burrow density making it difficult to differentiate between adjacent burrows, etc. For some burrows, the features which are species-specific are only seen in a proportion of the burrows of that species, for example, a particular type of excavation or feeding trace which is only visible after recent burrow maintenance or feeding activity. For other burrows, the configuration of openings may suggest a genus, but further information is needed before identification can be taken further.

Ground-truthing by various methods will improve accuracy of burrow recognition. These include:

1) Identification of species seen to be associated with burrows when using UWTV.
2) Examination of trawl catches from the area, identifying those species which are known from the literature to be facultative or obligate burrowers.
3) Examination of the burrowing fauna taken from the area by grab, box core, anchor dredge or hydraulic dredge.
4) Investigation of faunal records for area, noting burrow-dwelling species.
5) Consideration of grain size preference, geographical and depth range information for given species as indicated in the literature.

[2] Underwater television or video footage.

6) In those few cases where it is possible, direct observation by SCUBA diving. The diver is able to discriminate a level of detail beyond that possible from analysis of videotape. Further techniques available to the diver are suction sampling and resin casting. The former may extract the burrower, the latter enable detailed description of the burrow and accurate identification of the burrower (either from burrow structure or entrapment in the resin). Large burrows may be probed by hand and the occupant extracted.

The following key to burrow recognition using surface features visible at the scale of UWTV observation is therefore intended as a guide. With faunal or floral identification, accurate identification is virtually assured if the specimen is under direct examination. It is often much more difficult if a species is sighted but not captured. It is the same for burrows: with a resin cast of the burrow under examination, identification is relatively straightforward; identification by observation of burrow surface features alone is, in many cases, difficult and sometimes impossible. The key is a reasonable working tool which can be updated and refined as more information on burrow morphology is acquired.

The key includes burrowers from a wide range of particulate substrata (sands, muddy sands, sandy muds, muds, muddy gravel), from the eulittoral of beaches and lagoons to deep water in the Mediterranean and coastal NE Atlantic. Some of the species included do not occur on *Nephrops* grounds, others occur there only rarely. *Nephrops*, however, has a wide depth distribution (4–800 m) and constructs burrows in muddy sands, sandy muds and muds. The depth and substratum preferences of many of the species listed in the key are not well defined and vary geographically. Thus, for many species, overlap with *Nephrops* on some grounds and in some areas cannot be excluded on the basis of perceived habitat preferences. Thus, in the central Adriatic, the Squilla mantis grounds are principally on inshore muddy sands and the *Nephrops* grounds are further offshore on soft muds. There is, however, a zone of sandy mud between these grounds where both species occur. Therefore, substratum type has not been used as a dichotomous character in the key. The key does, however, include notes on substratum preference (based on habitat records in literature and personal observations).

Because many burrow-dwelling species are found both in the NE Atlantic and Mediterranean, geographical range has not been used as a dichotomous character. The key does, however, include notes on geographical range. Water depth is given in general terms only, since for many species there is a paucity of data and since there appears to be wide geographical variation for some species.

The diameter of burrow openings has been used as a dividing character in the key. This also should be used with some caution, as with the distance between openings of a given burrow, since these features will vary with the size/age of the burrower. Whether the burrow is vertical or oblique/horizontal is a useful dividing character. This difference can be determined from UWTV, even when the camera is mounted to give an oblique forwards view. Some care has to be exercised, however, since for several species, some openings are of vertical shafts while others in the same system are the openings of oblique tunnels.

Whether or not the openings of a given burrow form a characteristic cluster is also a useful criterion. Again, there will usually be some members of the population whose burrows do not conform to the usual pattern, perhaps because of the stage of burrow development, or because of collapse of some openings, etc., so some care has to be exercised when interpreting burrow clusters. The shape of openings is also instructive, as is the presence of tracks and trails, pellets or mounds of ejecta, excavatory scours and feeding traces (e.g. proboscis marks) - features which betray the identity of the occupant.

Some burrows are identified by more than one route in the key, e.g. callianassids and echiurans, since several, differently-keyed characteristics are diagnostic.

Some species occupy burrows constructed by others, e.g. various polychaetes, bivalves, shrimps, squat lobsters and fish. These may co-exist with the burrow-constructing species (endoecism) or may occupy burrows that have been vacated by the original occupant. Also complex burrows arise from the interconnected burrows of several species. All of this adds to interpretational complexity.

Recognition and enumeration of *Nephrops* burrows as evidenced from surface features

1) At least one burrow opening is usually distinctly crescentic in shape. Where the angle of view permits sight of the tunnel beyond this opening, the angle of descent is usually shallow.
2) There is often evidence of expelled sediment, usually in a broad delta-like ‘fan’ at the burrow opening, and scrapes and tracks made by the chelipeds and pereiopods are often apparent. These features and a clean, uncollapsed burrow opening suggests current occupancy (collapsed or partially collapsed burrows are unlikely to be occupied and should be ignored). However, beware if there has been recent passage of a trawl – displaced sediment may have spilled into occupied burrows and may yet to be cleared by the occupant. An occupied burrow may have both collapsed and functional openings.

3) Secondary openings may be similarly crescentic but are often more circular and with a steeper connecting tunnel/shaft.
4) Look for clusters of openings that appear to be related (i.e. interconnected) and count these as individual burrows (= burrow systems). Simple burrows are linear. More complex burrows are T-shaped with three openings and may be further elaborated. Look for configurations of openings that appear to converge on a central region. Openings/tunnels that are orientated in a different direction are likely to belong to a separate burrow.
5) Some burrow systems are complex conjunctions of the tunnels of an adult and one or more juveniles. Such burrows should be counted as a single burrow.
6) Burrows may have different morphologies on grounds that have different characteristics (sediment type, density of *Nephrops* and other burrowers, depth, area, etc.). For example, on some deep Aegean grounds *Nephrops* burrows appear to be more complex than on shallower Mediterranean grounds. Also, in soft sediments burrows often appear to make steeper angles with the plane of the sediment surface than burrows from coarse grounds. Grounds where hydrographic conditions concentrate larvae/ postlarvae are often characterised by small *Nephrops* at high density amongst a high density of burrows of other species such as Calocaris macandreae: the type of sediment present in such areas depends on local hydrography and differs geographically. Burrow openings on recently trawled grounds may appear atypical. Get your eye in for the characteristics of *Nephrops* burrows on the ground being counted. Take particular care on high density grounds and in conditions of poor visibility.
7) For a given ground, get familiar with the burrows of species that can be confused with those of *Nephrops* so that misallocation errors are reduced. Where possible, on difficult grounds it useful to observe the ground at the time of peak emergence of *Nephrops*. This will improve confidence in correct allocation of burrow identity. Unfortunately, some of the species whose burrows may be confused with those of *Nephrops* rarely or never emerge under normal conditions.
8) On high density grounds several *Nephrops* burrows are often visible at the same time: take care to differentiate between them by considering directions of tunnels, sizes and shapes of openings, etc.
9) Some grounds are characterised by burrows of very small *Nephrops*. If these animals are smaller than those caught in the fishery, or used for biomass determinations, should they be enumerated?

Make use of training material and regularly check performance.

Key to identity of sea bed burrows in NE Atlantic and Mediterranean waters using surface features

1.	Burrow opening(s) < 5mm in diameter.	probably macrofaunal polychaetes, etc: not covered in key
	Burrow opening(s) > 5mm in diameter.	**2**
2.	Burrow descending vertically or near vertically.	**3**
	Burrow descending at shallow angle, becoming near-horizontal.	**20**
3.	Surface opening(s) >2cm in diameter.	**4**
	Surface opening(s) <2cm in diameter.	**6**
4.	Large opening (up to 20cm at plane of mud surface) to deep (up to 1m) shaft; sometimes an oblique side tunnel opening to surface adjacent to shaft; smaller burrows of other species may surround shaft and connect with it; usually a conspicuous mound of excavated sediment at shaft opening. In muddy sediments (either fine or coarse) over wide depth range in NE Atlantic & Mediterranean	*Cepola rubescens*
	Burrow with one or two openings, without conspicuous mound(s) of excavated sediment at opening(s)	**5**
5.	Either a single circular opening to a burrow which is often dilated just below plane of sediment surface (this is usually the modified burrow of another species), or two equal-sized, circular openings at either end of a steep U-shaped burrow (may also be the modified burrow of another species). Inshore muddy substrata in NE Atlantic & Mediterranean	*Gobius niger*
	Burrow with two circular openings (which may be up to 1m apart and 50mm or more in diameter), one of which is larger than the other. Mediterranean, in muddy sands and sandy muds.	*Squilla mantis*

NB: There are a number of other burrow-dwelling stomatopods in NE Atlantic and Mediterranean waters, some occurring on deep muddy grounds. All are smaller than *S. mantis*: little is known of their burrows but they may well be similar to those of *S. mantis* in structure, though smaller.

6.	Only one burrow opening apparent	**7**
	Clearly more than one burrow opening	**11**
7.	No obvious burrow lining.	**8**
	Obvious lining, i.e. a dwelling tube.	cerianthid or polychaete
8.	No burrow-associated trace visible on sediment surface; burrow not in mound.	identity unconfirmed
	Burrow-associated trace visible on sediment surface and/or burrow opening at apex of mound.	**9**
9.	Burrow in apex of mound of sediment ejecta**.**	**10**
	Spoke-like traces, either spatulate in shape, or bifid distally, extending from burrow; may radiate through 360o; usually in flat sediment, occasionally associated with mounds.	echiuran

NB: The proboscides responsible for the traces may be seen and aid identification, e.g.
***Maxmuelleria lankesteri* (NE Atlantic) - large, green, spatulate proboscis**
***Maxmuelleria gigas* (Mediterranean) - large, greenish-grey, spatulate proboscis**
***Bonellia viridis* (NE Atlantic & Mediterranean) - large, green, bifid proboscis**

***Bonellia minor* (Mediterranean, possibly global) - small, green, bifid proboscis**
***Amalosoma eddystonense* (NE Atlantic) - large greenish-grey bifid proboscis**
***Thalassema thalassemum* (NE Atlantic & Med.) - small, pink or cream, undivided, very extensible proboscis**

***Maxmuelleria* spp. appear to be confined to fine sediments; the other species are reported from both fine and coarse sediments.**

There are other species recorded for the area, e.g. several *Maxmuelleria* spp. about which little is known. There are almost certainly new species awaiting description -*Ochetostoma azoricum* (large, olive green, spatulate proboscis) was first described from the Azores in 1996. Its burrows are similar to those of *M. lankesteri.* See also 10.

10.	Small (usually < 10cm diameter) mound; sediment often reduced (grey); hole at apex of mound often blocked.	possible exhalant shaft of callianassid (see **18**)
	Large (> 10cm diameter, often >30cm) mound; sediment reduced only in areas of most recent ejecta	possible exhalant shaft of echiurans – *Maxmuelleria lankesteri* (NE Atlantic), *M. gigas* (Mediterranean) or *Thalassema thalassemum* (both areas) - smaller mound than *Maxmuelleria* spp., often granular (faecal pellets)

NB: Little is known of echiuran burrow morphologies. Most have two openings, but these may be widely spaced and the connection between them is not apparent. See also 9.

11.	Closely-spaced (< 5cm) paired openings.	bivalve siphon holes e.g. *Thracia convexa*, *Solecurtus* spp.
	Openings not in closely-spaced pairs.	**12**
12.	Openings (3 or more) grouped into discrete clusters or loosely paired.	**13**
	Openings not grouped into discrete clusters.	**19**
13.	Some or all openings narrowed to form chimneys and therefore small and often inconspicuous; often 2 or 3 openings per burrow, but can be more.	upogebiids

- *Upogebia stellata* (eulittoral & sublittoral muddy sediments; NE Atlantic & Mediterranean)
- *Upogebia deltaura* (NE Atlantic - usually coarse sediments with admixture of mud; Mediterranean - deep water muds, but there is evidence that the Mediterranean entity is a different species)
- *Upogebia pusilla* (eulittoral and shallow sublittoral, muds & muddy sands; often lagoonal; NE Atlantic & Mediterranean)
- *Upogebia tipica* (shallow sublittoral; muddy sands; Mediterranean)
- *Upogebia mediterranea* (shallow sublittoral, in coarse sediment beside *Posidonia* beds; Mediterranean)
- *Gebiacantha talismani* (deep water muds; Mediterranean)
- Burrow descriptions are more detailed for some species than others.

	Burrow openings are not narrowed to form chimneys and therefore conspicuous; usually more than three openings per burrow.	**14**
14.	Openings wider than long (slit-like); may be very numerous; northern N Atlantic	*Maera loveni*
	Openings circular in cross section.	**15**

15. Openings often in threes or multiples of three; sublittoral muds, wide depth range; NE Atlantic and Mediterranean. — *Calocaris macandreae*

Openings may be paired or occur in clusters, but without a regular pattern of threes. — **16**

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16. Obvious lining present, usually projecting above sediment plane; a 2-opening dwelling tube. — *Chaetopterus variopedatus*

No obvious lining present. — **17**

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17. Ring of openings (usually 4-7) in a shallow depression, around a central cone with a hole at its apex; occur in pairs, each ca 20cm in diameter. Inshore muddy sands, sandy muds and muds, NE Atlantic & Mediterranean. Another similar burrow seen in deep Mediterranean waters consists of a single ring of ca 10 holes without a central cone or hole burrower identities — unknown; possibly enteropneusts

Openings do not form a ring. — **18**

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18. Burrow, in muddy sediments, over wide depth range, consists of one or more deep inhalant shafts (up to 2cm in diameter), often with funnel-like openings, associated with one or more small mounds marking the sites of exhalant shafts. These mounds may have an apical hole, but this is often blocked by loose, pelletized sediment. Burrows in sandy muds and muddy sands have more inhalant shafts than in soft muds. NE Atlantic and Mediterranean. — *Callianassa subterranea*

Burrow, usually in sandy sediments and shallow water, consists of several narrow (< 1cm), inhalant and exhalant shafts, the former may have funnel-like openings, the latter may be set in mounds, but in a high energy environment these features may be obscured by wave and current action. Dramatic mound and valley topography may occur in low energy environments. Burrows may occur at high density. — other callianassids

- *Callianassa tyrrhena* (eulittoral & shallow sublittoral; NE Atlantic & Med.)
- *Callianasa truncata* (shallow sublittoral; Mediterranean)
- *Callianassa candida* (shallow sublittoral; Mediterranean)
- *Callianassa acanthura* (shallow sublittoral; Mediterranean)
- *Calliax punica* (shallow sublittoral; Mediterranean)
- *Calliax lobata* (known only from sublittoral canyon type locality; Med.)
- *Gourretia denticulata* (probably coarse grounds, habitat uncertain; Med.)
- Little is known of the burrow morphologies of most of these species.

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19. Burrow consists of two, widely-spaced (sometimes > 1m) holes, one in a large mound and the other (which may have spatulate traces radiating from it) in flat sediment; relationship between holes difficult to determine. — *Maxmuelleria lankesteri* (NE Atlantic) or *M. gigas* (Mediterranean)

NB: *Thalassema thalassemum* may have a similar burrow morphology in some sediments, but there is little information. The animal is much smaller than *Maxmuelleria* spp. and the burrow features are correspondingly smaller. NE Atlantic and Mediterranean.

Variously-spaced holes in sediment for which interconnections may be inferred by their configuration or by observation of sediment plumes displaced by water currents within burrow

	(e.g. by diver or by passage of TV sledge).	various burrows whose occupants have yet to be determined.
20.	Distance between connected main openings usually > 50cm	**21**
	Distance between connected main openings usually < 50cm	**23**
21.	Crescentic, often large (> 10cm diameter) openings (commonly 2 or 3, sometimes more); spoil heaps around some or all of openings; tracks, if visible, include elongate (claw marks) and styliform (footprints) indentations radiating from burrow openings. In muds, sandy muds and muddy sands; wide depth range, NE Atlantic & Mediterranean.	*Nephrops norvegicus*
	Crescentic openings, usually < 5cm diameter; either curved scrapes or crenate ejecta mounds at one or more openings.	**22**
22.	Distinctive, curved scrapes at one or more burrow openings; commonly 2 or 3 burrow openings, but may be numerous; no closed (backfilled) openings. Muds, sandy muds and muddy sands: wide depth range; NE Atlantic & Mediterranean.	*Goneplax rhomboide*
	NB: Other crabs construct burrows in appropriate environments, e.g. *Carcinus maenas* (NE Atlantic inshore muds when no other cover present), *Monodaeus couchi* (sublittoral muds when no other cover present, including deep water muds in the Mediterranean; also occurs in NE Atlantic), *Brachynotus gemmellari* (inshore muddy sands; Mediterranean). Geryon trispinosus (=G. tridens) constructs large burrows in deep water muddy sediments: there is a large elongate scour at the burrow opening. Little is known about burrow structure, but most appear to be simple, shallowly-shelving tunnels with a single opening.	
	Distinctive crenate ejecta mounds beside one or more burrow openings (which may be numerous); at least two openings per burrow are open, others are closed (backfilled) - a distinctive diagnostic feature; some openings are of obliquely descending tunnels, others are of vertical shafts. In muds (usually fine-grained) over wide depth range; NE Atlantic & Mediterranean	*Jaxea nocturna*
23.	Distance between burrow's main openings usually 30-50cm.	**24**
	Distance between burrow's main openings usually < 30cm	**26**
24.	Burrow usually has 2 or 3 openings, sometimes more; openings usually small and crescentic, sometimes with elongate depression beside opening; tunnel junctions at 60o - may be deduced from angle of tunnels at openings. Usually fine mud grounds; northern N Atlantic	*Lumpenus lampretaeformis*
	Simple burrow (apparently), probably with two openings.	**25**
25.	Small (< 3cm) openings; in fine mud substrata; NE Atlantic & Mediterranean	possibly *Myxine Glutinosa*
	Relatively large (> 3cm) openings. (=*Antonogadus megalokynodon*) or	Possibly *Gaidropsarus biscayensis*
		Ophidion spp. Mediterranean)
	NB: A number of elongate fish are implicated as facultative or obligate burrowers. Almost nothing is known of their burrows or burrowing behaviour. At the present state of knowledge, it is impossible to identify such burrows by surface features alone. It is necessary to see the fish entering, leaving or within a burrow opening. Even then, care has to be exercised since the burrow may be that of another species.	

26. Burrow usually has 2 or 3 openings, either crescentic or circular in appearance; may be small pellets of ejected sediment at one or more openings. In mud, sandy mud & muddy sand; NE Atlantic & Mediterranean. *Lesueurigobius friesii*

NB: other small fish, e.g. *Enchelyopus cimbrius* (N Atlantic), may produce burrows of similar structure, but very little is known about them (there is some information for NW Atlantic specimens but they occur on different grounds) –NE Atlantic *E. cimbrius* is often seen in hollows in the mud and some have been observed to swim into burrows when disturbed. Presumably burrow size will vary with fish size. *Zosterisessor* (= *Gobius*) *ophiocephalus* constructs burrows in Mediterranean lagoons, amongst *Zostera*, but does not occur on *Nephrops* grounds.

Burrow often with 2 or 3 small openings, sometimes more, crescentic or circular in appearance; elongate scours may be visible at one or more openings, also small spoil heaps. *Alpheus glaber*

NB: Other Caridea may construct similar burrows: there is little information at present. Some carideans cohabit in the burrows of other species, e.g. *Processa nouveli holthuisi* in the burrows of *Callianassa subterranea* and *Maxmuelleria lankesteri* and *Athanas amazone* in the burrows of *Squilla mantis*.

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Annex I: Simple Sea-pen species identification guide for use with video footage .

Source: Greathead et al. (2007)

Table 1. *Species identification characteristics for* Virgularia mirabilis, Pennatula phosphorea *and* Funiculina quadrangularis.

	Virgularia mirabilis	*Pennatula phosphorea*	*Funiculina quadrangularis*
Colour	Off-white to yellow	Dark red with white polyps	White to pink
Shape	Very straight and slender with short leaves	Long leaves giving a distinctive feather shape and a shepherd's crook at the top of the rachis	Very long but thicker than *V. mirabilis* with a curve like a human backbone
Size	Up to 40 cm protruding from the sediment	Up to 25 cm protruding from the sediment	Up to 150 cm protruding from the sediment
Other features	May be partly retracted into the sediment with only a small section of the animal visible	May be partly retracted into the sediment with only a small section of the animal visible	Immature or small specimens may be confused with *V. mirabilis* except for the curved shape stockier appearance and pinkish tinge

Annex II: SACFOR abundance scale used for both littoral and sublittoral taxa from 1990 onwards.

Source : ***http://www.jncc.gov.uk/page-2684***

NB. Read notes below prior to use of scale

Growth form	**Size of individuals/colonies**							
% cover	**Crust/meadow**	**Massive/Turf**	**<1cm**	**1-3 cm**	**3-15 cm**	**>15 cm**	**Density**	
>80%	**S**		**S**				**>1/0.001 m2 (1x1 cm)**	**>10,000 / m2**
40-79%	**A**	**S**	**A**	**S**			**1-9/0.001 m2**	**1000-9999 / m2**
20-39%	**C**	**A**	**C**	**A**	**S**		**1-9 / 0.01 m2 (10 x 10 cm)**	**100-999 / m2**
10-19%	**F**	**C**	**F**	**C**	**A**	**S**	**1-9 / 0.1 m2**	**10-99 / m2**
5-9%	**O**	**F**	**O**	**F**	**C**	**A**	**1-9 / m2**	
1-5% or density	**R**	**O**	**R**	**O**	**F**	**C**	**1-9 / 10m2 (3.16 x 3.16 m)**	
<1% or density		**R**		**R**	**O**	**F**	**1-9 / 100 m2 (10 x 10 m)**	
					R	**O**	**1-9 / 1000 m2 (31.6 x 31.6 m)**	
						R	**<1/1000 m2**	

Use of the MNCR SACFOR abundance scales: The MNCR cover/density scales adopted from 1990 provide a unified system for recording the abundance of marine benthic flora and fauna in biological surveys. The following notes should be read before their use:

1. Whenever an attached species covers the substratum and percentage cover can be estimated, that scale should be used in preference to the density scale.
2. Use the massive/turf percentage cover scale for all species, excepting those given under crust/meadow.
3. Where two or more layers exist, for instance foliose algae overgrowing crustose algae, total percentage cover can be over 100% and abundance grade will reflect this.
4. Percentage cover of littoral species, particularly the fucoid algae, must be estimated when the tide is out.
5. Use quadrats as reference frames for counting, particularly when density is borderline between two of the scale.
6. Some extrapolation of the scales may be necessary to estimate abundance for restricted habitats such as rockpools.
7. The species (as listed above) take precedence over their actual size in deciding which scale to use.
8. When species (such as those associated with algae, hydroid and bryozoan turf or on rocks and shells) are incidentally collected (i.e. collected with other species that were superficially collected for identification) and no meaningful abundance can be assigned to them, they should be noted as present (P).