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Devon's Shores and Shallow Seas: Ecology and Conservation of Seabed Habitats and Species

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Accounts of the marine life around Devon can be traced back to the nineteenth century. However, it was only from the end of that century that studying marine life included understanding the sorts of seabed habitats that species lived in and the assemblages of species that characterised those habitats. A great deal of leading work was carried out from the Marine Biological Association Laboratory in Plymouth to describe what was where. When scuba diving became possible from the 1950s, Devon again provided the 'springboard' for describing the rocky habitats of our shallow seas. Over the past 45 years, marine conservation imperatives have triggered a great many descriptive surveys of seabed habitats and several marine protected areas have been established around Devon since the designation of Lundy as Britain's first Marine Nature Reserve in 1973, reflecting the great variety of seashore and seabed habitats around our coast and the presence of many special features.

INTRODUCTION AND HISTORICAL PERPECTIVES

Devon's coast and shallow seas support a great variety of marine habitats and, therefore, species. The south and the north coasts are very different environments and Lundy stands on its own as particularly rich and varied.

The seashore life of Devon's coasts provided a starting point for much of what we know today about marine natural history. There were some very early studies that were recorded in Gerald Boalch's Presidential Address to the Devonshire Association, published in 1996. Naturalists such as George Montagu at the end of the eighteenth and beginning of the nineteenth century were followed by George Tugwell, Charles Kingsley and Philip Henry Gosse in the middle and later nineteenth century. Remarkably, in 1848, dredge samples were taken to the east of Lundy to identify the seabed fauna there (Forbes, 1851). There was little other dredging to describe the seabed marine life although there is a detailed description in Gosse (1865) of a location in Torbay.

Figure 1. *The location where, in 1852, Gosse discovered the scarlet and gold star coral at Ilfracombe is readily re-found from his description. Here, in 1991, there are about 300 – the tiny orange dots. The inset is Gosse's drawing of the species (from Gosse, 1853). Image: Keith Hiscock, September 1991.*

The nineteenth century also saw the popularisation of natural history and the writing of many seashore books. Pre-eminent amongst marine naturalists in this field was Philip Henry Gosse. His forays to the shore led to the writing of enthusiastic descriptions from places such as Ilfracombe and Torbay (in particular '*A naturalists' rambles on the Devonshire coast*', Gosse, 1853, and '*A year at the shore*', Gosse, 1865). His '*History of British sea-anemones and corals*' (Gosse, 1860) includes many references to locations in Devon; perhaps, most notably, his finding of a species new to science: the scarlet and gold star coral *Balanophyllia regia* at Ilfracombe (see Fig. 1). Some of those descriptions of particular locations provide a basis for comparison today. However, much of the collecting of marine life on the shore was undertaken without regard for those that might come afterwards. George Henry Lewes, writing in 1858 advises the equipment for a day's hunting as including:

> "a geologist's hammer (let it be a reasonable size), and a cold chisel; to these add an oyster-knife, a paper knife, a landing net, and, if your intentions are serious, a small crowbar".

Towards the end of the nineteenth century, marine biology was being pursued in a systematic manner to answer questions about what species lived where and what sorts of assemblages of species occurred in what sorts of habitats. Most subtidal sampling was by use of dredges and trawls and the work undertaken by Edgar Johnson Allen, Director of the Marine Biological Association from 1894 to 1836, was outstanding. Although not intending to establish a classification of seabed communities, data were organised and presented in a way that demonstrated how certain species characterised different physical habitats (Fig. 2).The work undertaken at Plymouth led to the compilation of the '*Plymouth Marine Invertebrate Fauna*' in 1904: the precursor of many such detailed accounts of local marine faunas. The '*Victoria History of the County of Devon*' (Page, 1906) is remarkable in bringing-together lists of the species of marine algae and animals that were then known from around Devon and there are also a few descriptions of seashore and seabed habitats.

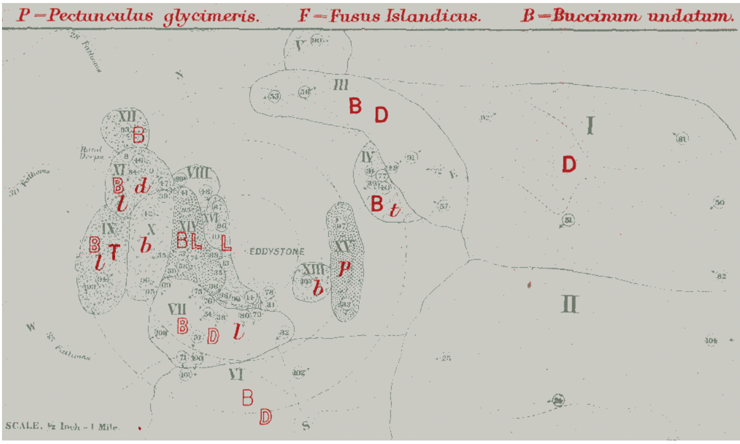

Figure 2. *Part of one of the charts prepared by E. J. Allen showing the distribution of bottom types (habitats) and abundance of species in the region of the Eddystone Reef. The Roman numerals refer to the bottom type. The letter codes are for the species named in red along the top (not all are shown in this clip). Solid large letters are for 'very abundant presence', hollow letters for 'only one or two stray specimens'. From Allen (1899).*

It is the description of seashore and seabed habitats and the assemblages of species that characterise them that I will particularly address in this paper. Remote sampling of seabed habitats continued, most notably the work of Ebenezer Ford offshore of Plymouth Sound in the early 1920s following the pioneering methods developed by Petersen (1914) that used a grab to take quantitative samples of seabed marine life (Fig. 3).

It was not until marine biologists started to use primitive diving equipment in the 1930s, then scuba equipment from the 1950s and, later, towed camera sledges that Kingsley's longing to 'see it all but for a moment' (in '*Glaucus or the Wonders of the Shore*': Kingsley, 1890) was to be fulfilled. The reference to diving in the 1930s refers to a remarkable study undertaken by Kitching *et al*. (1934) in a submarine gulley at Wembury in South Devon. Equipped with an especially constructed helmet that was fed air from a hand-operated pump, the three co-workers sampled a shallow gulley at Tomb Rock (Fig. 4). The site was briefly re-surveyed in July 1986 during a survey of Plymouth Sound and estuaries commissioned by the Nature Conservancy Council (Hiscock and Moore, 1986) and the conspicuous species found to be much as described in 1931.

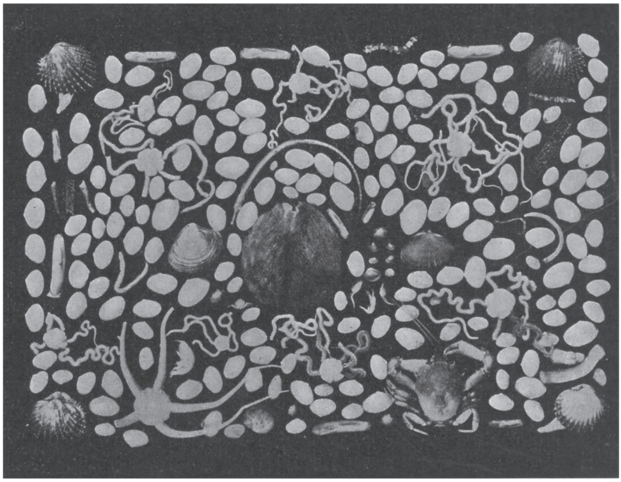

Figure 3, *The contents of one 0.1 m^2 grab sample collected by Ebenezer Ford (acknowledged as* Naturalist at the Plymouth Laboratory*) at a depth of about 25 m in Bigbury Bay. The assemblage represented was named the* 'Echinocardium cordatum - Venus gallina' *community although the numerically most abundant species is the bivalve* Abra alba *accompanied by another common species in sediments, the brittle star* Amphiura filiformis. *From Ford (1923).*

Figure 4. *Thomas Macan about to enter the water to sample subtidal marine life in 1931 near Wembury in South Devon. Image: Jack Kitching.*

There was very little work being undertaken on the shores of North Devon in the first three quarters of the twentieth century, although intertidal algae were extensively sampled on the mainland coast and at Lundy by George Tregelles (Tregelles, 1931, 1937). The work of Leslie and Clare Harvey in the late 1940s documented the intertidal marine life at Lundy and provided detailed raw data enabling later comparisons of the species present to be made.

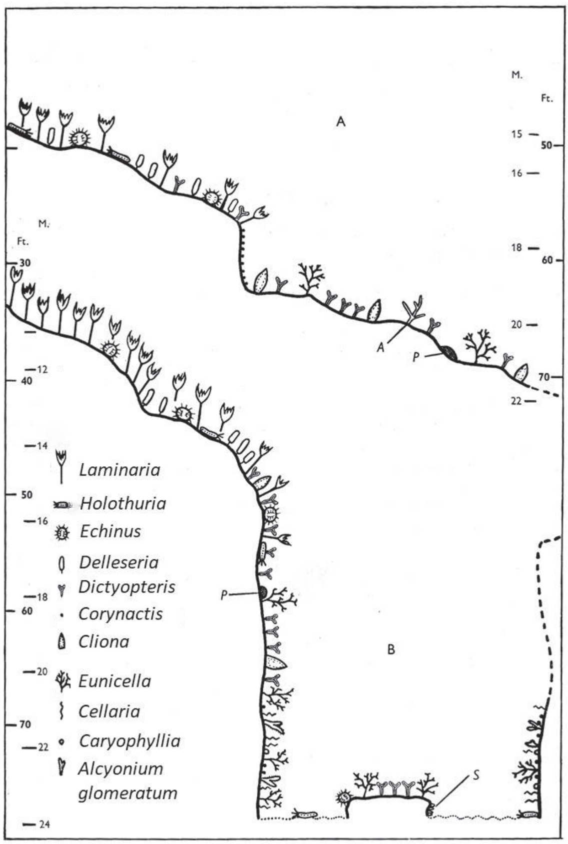

Figure 5. *Diagrammatic profiles at Hilsea Point Rock in 1953 in one of the earliest studies of rocky subtidal habitats by scuba diving (Forster, 1954). Image from the* Journal of the Marine Biological Association of the UK *adjusted to enlarge species names. Letter codes for species are: A* = Axinella*; P* = Pachymatisma*;* *S* = Stolonica socialis.

When scuba diving became possible from the 1950s, Devon again provided the 'springboard' for studies of the rocky habitats of our shallow seas. Bob Forster, a staff member at the Marine Biological Association in Plymouth, was the earliest marine biologist to use scuba diving in Britain and published several descriptions of the characteristic macrofauna of hard substrata (rocks and the wreck of the *James Eagan Layne*) along the south Devon coast. Fifty years on from his description (Fig. 5) of Hilsea Point Rock (known, in 1953, as Stoke Point Rocks), I re-surveyed the site and found it, with a very few significant differences, much as described in 1953 (Hiscock, 2005).

In the late 1960s, 1970s and 1980s, Lundy became the focus for developing and using techniques for surveys using scuba diving and to document the marine flora and fauna there. Diving was an essential part of a major survey of marine algae of Lundy (Irvine *et al.*, 1972). The subsequent surveys were mostly reported in limited circulation reports and in the Annual Report of the Lundy Field Society.

While Bob Forster was starting to use scuba diving for marine biology surveys, Norman Holme was using a dredge extensively in the English Channel to investigate the distribution of species. By the early 1960s, Holme was also taking advantage of new video technology together with colour photography and the advent of strobe flashguns to survey areas of level seabed. Those studies, using a towed sledge, gave a visualisation of the seabed and its associated marine life (see Fig. 6). Extensive areas along the south coast of England were surveyed, the information providing a basis for later studies that might document change. That work continued with improving technology into the 1970s. The images are preserved in the archives at the Marine Biological Association. We audited the collection in 2004 but there has been no full analysis of the images.

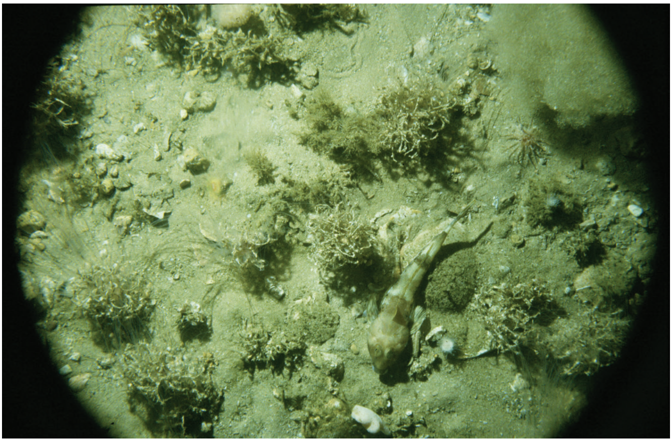

Figure 6. *An image of the seabed at 78 m depth south of the Eddystone Rock. The 35 mm photograph was taken using a towed photographic array in June 1975 and shows, most conspicuously, 'balls' of sediment attached to the tentacles of terebellid worms, the sea anemone* Mesacmaea mitchelli *(top right), some small soft corals* Alcyonium digitatum *and a dragonet* Callionymus *sp. (Image: Norman Holme/Marine Biological Association.)*

It was in the 1970s, 80s and 90s that surveys commissioned by the nature conservation agencies would catalogue the marine life present in North and South Devon and at Lundy and lead to the identification of distinctive assemblages of species that reoccurred in similar environmental conditions: a classification of marine biotopes (the physical habitat with its associated community of species) was created and much information came from around Devon. The surveys commissioned by the Nature Conservancy Council and its successors are outstanding in what they have revealed. Those surveys contributed to or were a part of the Marine Nature Conservation Review of Great Britain (MNCR). The MNCR reviewed what was known about marine life along the coasts of Devon in Hiscock (1998) and the reader should refer to that volume for detailed information – only some highlights will be repeated in the sections that follow. The results of MNCR surveys were described in a large number of reports and generated data that is now disseminated electronically and there are two published reports that summarize some of the inshore data from Devon (Moore *et al.*, 1998, 1999).

A great deal of what we know about Devon's marine life is in limited circulation reports rather than scientific journals: publishing the results of yet another survey is not attractive to a journal! Information from those unpublished surveys was entered to a computer database which became a standard tool for data entry: Marine Recorder. In turn, those records could be mapped to indicate the distribution of species and identify ones that are rare and scarce. As more data are collected, comparisons can be carried-out of species occurrences in different years, tracking change brought about by climate variability and arrival of non-native species. Those interested to know what is where both in terms of the biotopes present at a location and to see the lists of species recorded in surveys, now have access to map-based electronic resources: in particular, at the time of writing, www.emodnet-seabedhabitats.eu and https://nbnatlas.org/ (Fig. 7).

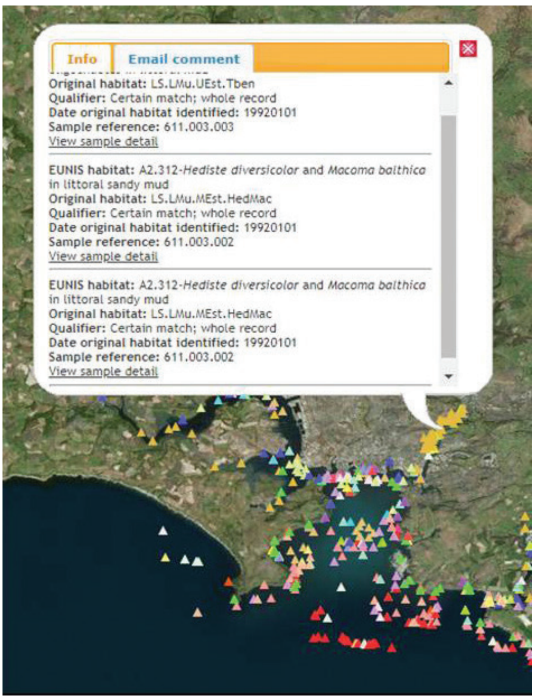

Figure 7. *The location of survey data points along the coast and shallow seas off south-west Devon. In this screen shot, a survey site in the Plym Estuary has been interrogated. Species lists from the survey site can also be accessed. Information contained here has been derived from data that is made available under the European Marine Observation Data Network (EMODnet) Seabed Habitats project funded by the European Commission's Directorate-General for Maritime Affairs and Fisheries (DG MARE).*

Our knowledge of what is where along the coasts and shallow seas of Devon increased enormously from the 1970s onwards. So also have the resources that enable identification of what we see and information on the interactions that occur between environment and species. An excellent way to view and understand what is out there is to see it for yourself. If getting onto the shore, sampling from boats or scuba diving is not possible, then books, photographs and video now bring-to-life the best of our marine wildlife.

HABITAT DESCRIPTONS

Introduction

Here, I introduce some of the highlights of marine life present on the shores and in the shallow seas around Devon. These highlights may give clues about the importance of certain locations and features for biodiversity conservation, science, education and enjoyment. There is a detailed description in Hiscock (1998) but much more research has been undertaken since that publication. Very little of that information finds its way into published papers but limited circulation reports, Seasearch reports and data that finds its way into EMODnet (see Fig. 7) are readily available and easily found.

There are several ways in which the description of marine habitats could be presented but, here, I have chosen to separate open coast areas from marine inlets and, within those categories, intertidal from shallow subtidal habitats. A separate section mentions the open seas and the species that live in the water column.

The *Plymouth Marine Fauna* (last published in 1957 and now available on-line) is much more than just a list. It includes notes on habitat preferences, locations where species are found, seasonal occurrences, breeding activities, disease events, *etc*. Similarly, the series of lists of marine fauna at Lundy introduced in Hiscock (1974). Such information is invaluable when trying to explain change. Phycologists do less well for additional detail as their floras are mainly lists of what is where (for instance, Devonshire Association, 1952). The Marine Biological Association and Scottish Marine Biological Association Intertidal Survey Unit surveyed marine communities present in the littoral zone (Powell *et al.,* 1978; Bishop and Holme, 1980) and the results of those surveys contributed to the MNCR. Results from those surveys are published in limited circulation reports (mostly referenced in Hiscock, 1998) and included in relevant databases.

Open Coasts

Intertidal areas: Intertidal areas around the coasts of Devon (Figs 8, 9, 10) have long been popular collecting grounds as well as convenient locations for educating students about some of the principles of ecology (for instance, from Slapton Ley Field Centre). Sediment shores are mainly of highly mobile sand with a reduced fauna and it is the rocky shores that include a wide variety of species. Papers in journals that specifically describe shores in Devon have many purposes. Some look at species composition in different zones and habitats, some are designed to monitor change.

Figure 8. *Rocky coasts moderately exposed to wave action, such as those on north-facing coasts in North Devon (here, at Combe Martin), are typically colonised by algae with steep faces and upper shore areas dominated by limpets and barnacles. Image: Keith Hiscock, 6th May 2008.*

Figure 9. *The Eddystone Rock in Devon (though administratively in Cornwall) are 14 km south of Rame Head in Cornwall and are the most wave-exposed intertidal rocks on the south coast with communities dominated by limpets and barnacles and only sparse algae. Image: Keith Hiscock, 1st July 2012.*

Figure 10. *Shores that are sheltered from strong wave action and have a range of habitats including shallow pools, overhangs and turnable boulders are rich in marine life. Here at Wembury Point in south Devon. Image: Keith Hiscock, 10th April 2009.*

On Lundy, the shores surveyed by Leslie and Clare Harvey in the late 1940s and in 1950 were re-surveyed in 2008 and in some subsequent years to establish that, compared with the 1940s, much the same number of species could be found but there were some not found and some new ones recorded. Those observations, together with the history of intertidal studies at Lundy, are documented in Hiscock and Brodie (2016). For intertidal and subtidal marine life, there is a check list of marine algae (Irving *et al.,* 1974) and a series that describes the marine fauna (introduced in Hiscock, 1974).

The open coasts of Devon have some unusual habitats which harbour species not usually found inter-tidally. They include, for instance, littoral caves that pepper the headlands and islets of Tor Bay and at Berry Head, many of which extend into the subtidal or are entirely subtidal.

Subtidal areas: The shallow seas (to about 70 m depth) off the coast of Devon include a mosaic of different habitats with an associated rich variety of species. Reef habitats predominate in many inshore areas and are characterised by kelps (large brown algae) in depths shallower than where about 1% of surface illumination penetrates (about 15 m below Chart Datum at the Eddystone Reef) with foliose algae (Fig. 11) surviving to depths where about 0.1% of surface light remains – as deep as 30m below Chart Datum in some clear waters offshore in south Devon, but to only about 6 m in turbid Bristol Channel waters near Lynmouth in north Devon. Deeper than the zone of algal domination and on vertical rocks, overhangs and in caves, sessile and sedentary animal species dominate the rocks. Some of the principles of rocky subtidal ecology with examples from Devon's waters (Fig. 12) are included in Hiscock (1985) and illustrated in Hiscock (2018).

Reef habitats are mainly protected from the destructive impacts of mobile fish gear although low lying ones have no doubt been damaged although evidence is mainly anecdotal. 'The Exeters' were a series of sandstone reefs popular with early divers off the mouth of the Exe that were reduced in height and extent most likely as a result of heavy mobile fishing gear (Colin Munroe, *pers. comm.*). In Lyme Bay, in 2008, scallop dredging (which had impacted low reef habitats and species) was prohibited in vulnerable areas and was followed by a subsequent increase in species richness and the abundance of certain fragile organisms (Sheehan, 2013). Where structural complexity makes the reefs a no-go area for mobile gear, there are many rare, scarce and fragile species to be found. They include those in Figure 13 and very long-lived and slow-growing erect sponges such as *Axinella dissimilis* (see Fowler and Laffoley, 1993).

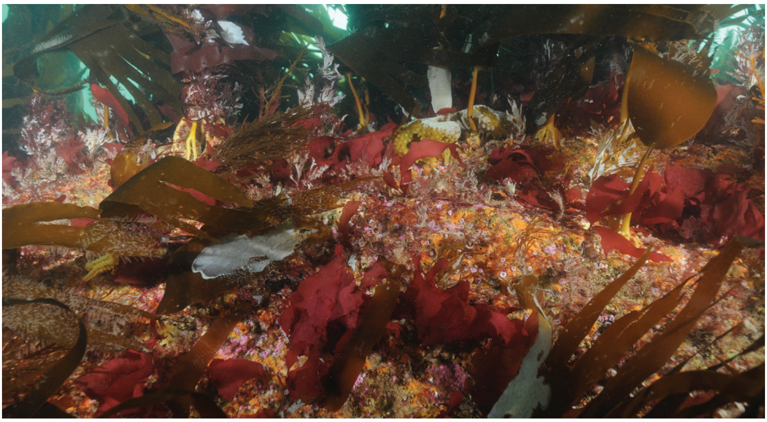

Figure 11. *Shallow subtidal rocks are visually dominated by algae – kelps in shallow water and, deeper, foliose algae. Here at Hilsea Point Rock east of Plymouth. The kelps are at about 5 m depth below Chart Datum. Image: Keith Hiscock, 22nd August 2015.*

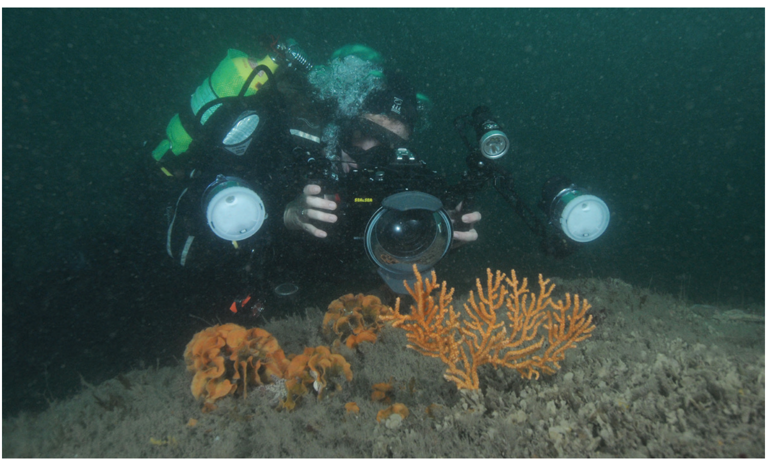

Figure 12. *Where insufficient light penetrates for algal growth to occur, animals dominate the rocky seabed. Here, off the west coast of Lundy at about 25 m below Chart Datum, the seabed is dominated by erect bryozoans (ross 'coral'* Pentapora foliacea *and hornwrack* Flustra foliacea *are most conspicuous here) with a pink seafan* Eunicella verrucosa. *Image: Keith Hiscock, 2nd August 2015.*

Figure 13. *Reef community on a submerged cliffline about 4 km south of Plymouth Sound breakwater and at about 32 m below Chart Datum. The nationally rare sunset cup coral* Leptopsammia pruvoti, *pink sea fans* Eunicella verrucosa, *two species of sea fingers* Alcyonium *spp. and a variety of other species constitute a community of marine natural heritage importance. Image: Keith Hiscock, 29th March 2009.*

Mention must be made of the marine life colonising wrecks off the coast of Devon. The communities are distinctive and, on parts that protrude into currents, are dominated by plumose anemones (*Metridium dianthus*) and dead men's fingers (*Alcyonium digitatum*) especially. Pink sea fans (*Eunicella verrucosa*) and Devonshire cup corals (*Caryophyllia smithii*) are often abundant but some sponges and anthozoans that occur on rock reefs do not colonise wrecks (Fig. 14). Examples from Devon's waters are illustrated and described in Hiscock (2018).

Extensive areas of sediments occur away from reefs. Off the south coast of Devon, these sediments range from coarse shell gravel to muddy sand with some areas of tide-swept pebbles and cobbles. Off the north coast, tidal currents are strong, seabed sediments are mainly coarse (including cobbles and pebbles) and can be very mobile and therefore impoverished because of scour. The most diverse sediment communities occur where the seabed is sheltered from strong wave action but exposed to tidal currents of moderate strength: for instance, off the east coast of Lundy (Fig. 15) or in marine inlets such as in the narrow parts of Salcombe Harbour and Plymouth Sound.

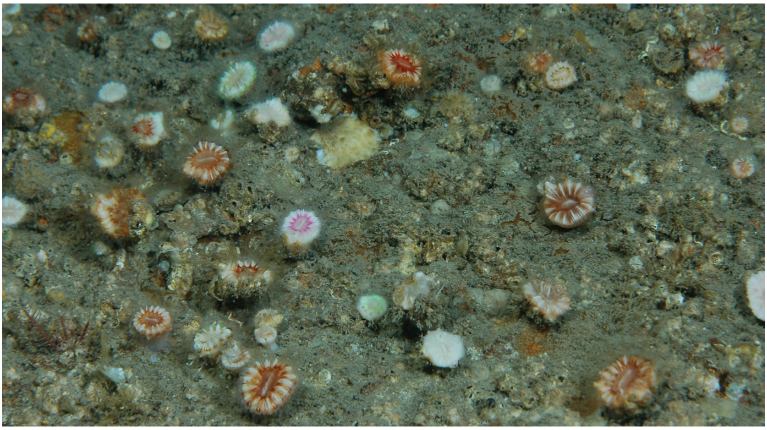

Figure 14. *The Devonshire cup coral* Caryophyllia smithii *readily colonises wrecks and may be present in high abundance. Here on the wreck of the Maine off Bolt Tail in South Devon. (The Devonshire cup coral is widely distributed around most of the British coast.) Image: Keith Hiscock, 12th October 2008.*

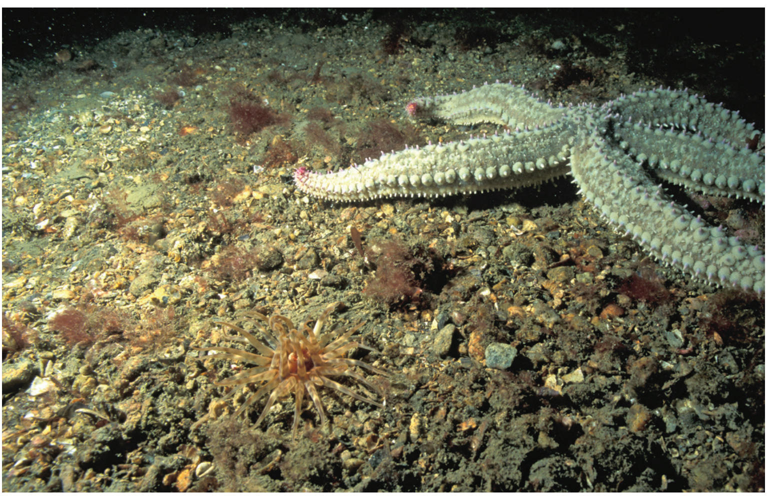

Figure 15. *Undisturbed areas of muddy gravel off the east coast of Lundy. A policeman anemone* Mesacmaea mitchelli *and a spiny starfish* Marthasterias glacialis *are conspicuous. Image: Keith Hiscock, July 2002.*

Harbours, Rias and Estuaries

Intertidal areas: The habitats that occur in bays, in rias (flooded river valleys) and estuaries are sheltered from wave action but often subject to variable or low salinity. Rocky shores are generally only widespread at the entrances to these marine inlets (Fig. 16) although man-made structures such as harbour walls and coastal defences create hard substratum even towards the upper limits of marine influence.

Figure 16. *The shores of Salcombe Harbour are considered by marine biologists to be particularly rich in species. Here at Woodville Rocks, the kelps are the southern golden kelp* Laminaria ochroleuca*: first recorded in Britain from Plymouth Sound in 1946 (Parke, 1948). Image: Keith Hiscock, 9th September 2014.*

Early studies of marine inlets include those of Allen and Todd (1902) who published a detailed description of the marine natural history of the Exe Estuary. Their account has become a valuable reference text against which more recent habitat changes may be evaluated. A comparison of the results of Allen and Todd (1902) with those of Dixon (1986) did not suggest any significant changes in the biota present. Bull Hill Bank, near the mouth of the Exe Estuary, was noted as one of only four British locations of the burrowing polychaete *Ophelia bicornis* (Dixon, 1986; Harris, 1991).

The intertidal sediment habitats of marine inlets are predominantly muddy (Figs 17 and 18) but, where rock habitats occur, they may be populated by species that only occur in estuarine habitats such as the hydroids *Hartlaubella gelatinosa* (found at Weir Quay; Fig. 17) and *Cordylophora caspia*.

Figure 17. *Estuaries such as the Taw and Torridge, Exe, Teign, Tamar, Plym, Kingsbridge and Dart include extensive mud habitats with high densities of burrowing species that are important for birds. They are, however, greatly modified by human activities. Here, the Plym Estuary has had extensive land claim and there are tiles laid in the mud to trap crabs for fishing bait. The estuary has also received substantial inputs of china clay waste. Image: Keith Hiscock, 15th March 2018.*

Figure 18. *Weir Quay, 12 km inland from the entrance to the Tamar Estuary at Devil's Point and where salinity is variable or low depending on the amount of freshwater input at any one time. The intertidal habitats have a very restricted range of marine species including some that are typical of low salinity conditions. Image: Keith Hiscock, 16th June 2007.*

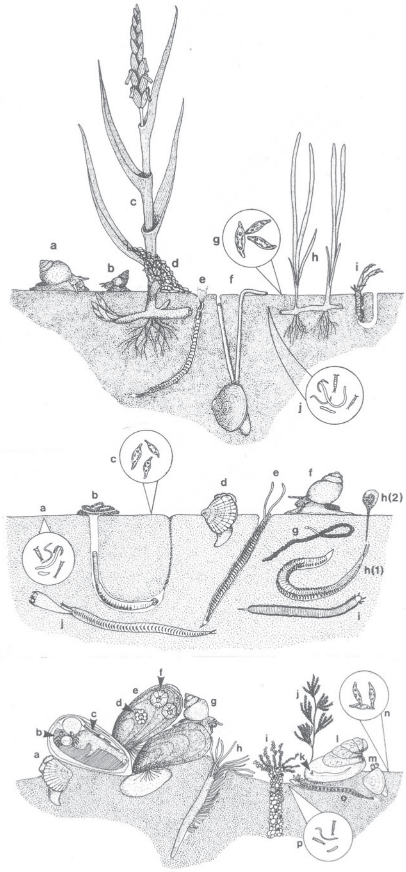

Figure 19. *Illustrations of three sediment communities identified in the Exe Estuary (from Harris, 1980).The scientific names were current in May 2018.*
1. Mud-shore community. a. Littorina *sp. b.* Peringia ulvae*, c.* Spartinatown sendii *var.* anglica*, d.* Vaucheria *sp., e.* Hediste diversicolor*, f.* Scrobicularia plana*, g. surface diatoms, h.* Zostera marina*, i.* Corophium volutator*, j. meiofauna.*
2. Sandy-shore community. a. meiofauna, b. Arenicola marina*, c. Surface diatoms, d.* Cerastoderma edule*, e.* Scolelepis squamata*, f.* Littorina littorea*, g.* Cephalothrix rufifrons*, h.* Scoloplos armiger*, h. (2). the egg-mass of* Scoloplos*, i.* Nephtys cirrosa*, j.* Glycera alba.
3. Mytilus *community. a.* Cerastoderma edule*, b.* Pinnotheres pisum*, c.* Mytilicola intestinalis*, d.* Austrominius modestus*, e.* Mytilus edulis*, f.* Semibalanus balanoides*, g.* Littorina littorea*, h.* Cirriformia tentaculata*, i.* Lanice conchilega*, j.* Sertularia argentea*, k.* Spirobranchus triqueter*, l.* Crepidula fornicata*, m.* Spisula solida*, n. surface diatoms, o.* Eunereis longissima*, p. meiofauna.*

Sediment communities are mostly out-of-sight and illustrations that show what those burrowing communities look like are rare. Figure 19 (from Harris, 1980) gives an impression of what is out of sight.

Salcombe Harbour and the Kingsbridge Estuary is one of the West Country's finest natural harbours. The inlet has a long history of marine biological study and is considered to be a site of international marine biological importance (Powell *et al.,* 1978). The first detailed survey was reported by Allen and Todd (1900) and the estuary was surveyed again in 1985 (Hiscock, 1986). The records in the *Plymouth Marine Fauna* (Marine Biological Association, 1957) from Salcombe Harbour reflect the extensive use of the area for sampling and teaching. Intertidal sediment communities are particularly rich with The Salt Stone and Tosnos Point worthy of special mention. Sea grass (*Zostera marina*) beds are extensive in the lower intertidal and subtidal and harbour a rich associated fauna and flora including occasional finds of the rarely encountered fan mussel *Atrina fragilis*.

Marine inlets have been extensively altered from what their character would be without human influence. They were industrial highways before the arrival of the railway and before the development of road networks. Their importance for transport especially led to the development of quays and bridges and to land claim that changed mudflats into level sites for building. They, especially the Tamar, also received contaminants from mines including arsenic. Anti-fouling paints, especially tributyl tin (now banned), on vessels have adversely affected seabed marine life although specific examples in Devon are few. Other contaminants and nutrients from agricultural runoff may adversely affect marine life. Now, it is mainly port and marina developments that change the character of inlets and introduce hard substratum where there may previously have been only sediment. Shipping and mariculture have also brought (and continue to bring) non-native species from ports around the world that now thrive in south-west marine inlets.

Subtidal areas: In marine inlets, sediment habitats tend to be populated by communities of species that are similar to those in the same substrata on open coasts. Some are now dominated by the non-native slipper limpet *Crepidula fornicata*. However, as salinity decreases or becomes variable, species richness decreases and an impoverished community of polychaete worms, amphipod crustaceans and some bivalve molluscs develops. Such communities are widespread. In contrast, reef habitats are of importance because they are unusual (for instance, see Fig. 20). Since ria habitats are flooded river valleys with deep water in places, there are often steep rocky slides especially in narrow sections where tidal currents are accelerated. The ria communities in the Tamar and at places in Salcombe Harbour are outstanding in their extent and the presence of distinctive biotopes.

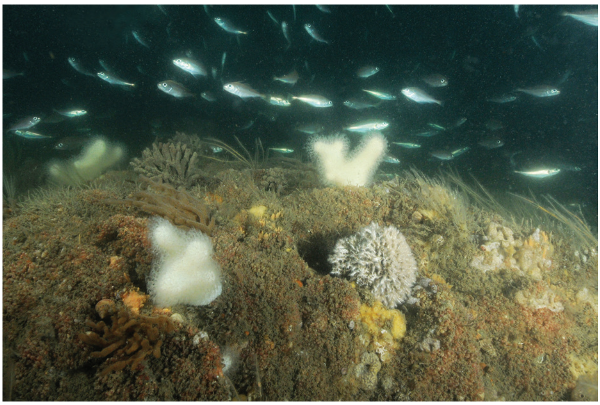

Figure 20. *A characteristic ria community off West Hoe at the entrance to the Tamar. Rocks are dominated by sponges and sea squirts with dead men's fingers* Alcyonium digitatum *and a colony of coral worms* Salmacina dysteri. *Poor cod,* Trisopterus minutus, *gather on the top of the cliff waiting for passing food. Image: Keith Hiscock, 9th July 2013.*

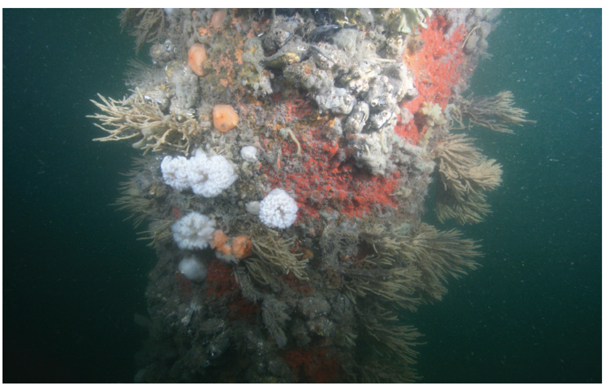

Figure 21. *The development of ports and marinas has introduced hard substratum into marine inlets where there was previously sediment. Here, the pontoon pilings in a marina on the Dart Estuary are festooned with marine life (mainly mussels,* Mytilus *sp. coated with a didemnid sea squirt, encrusting sponges, branching sponges* Haliclona oculata *and plumose anemones* Metridium dianthus*). Image: Keith Hiscock, 26th October 2017.*

Hard substratum also occurs in the form of harbour walls, jetty piles and marina pontoons (for instance, see Fig. 21) that, again, are populated by a distinctive community of species.

CONSERVATION

Introduction

'Conservation' (of nature) is the regulation of human use of the global ecosystem to sustain its diversity of content indefinitely, including restoration where necessary (based on Nature Conservancy Council, 1984). In the marine environment, conservation rarely requires the sort of manipulation that occurs on land to achieve a desired state. What it does require is prohibiting or minimising activities that may damage representative and special features. Recovery from damage that has occurred is most often achieved by leaving nature to take its course rather than re-introduction and whatever might be the marine equivalent of coppicing, burning, grazing, predator control, water flow management, *etc*.

Seashore studies were a rough affair in the nineteenth century. George Tugwell (Tugwell, 1856) writes of an expedition to Lundy in 1851:

> "We can do nothing without our man and the crowbar; his office is to turn over all those large weed-covered angular rocks which lie at the verge of the ebb-tide."

Impacts of human curiosity on seashore marine life were widespread but localised. Edmund Gosse, writing in 1906, commented on the beauty of marine life observed while accompanying his father onto the shore:

> "These rock-basins ...... thronged with beautiful sensitive forms of life - they exist no more, they are all profaned, and emptied and vulgarised. An army of 'collectors' has passed over them and ravaged every corner of them. The fairy paradise has been crushed under the rough paw of well-meaning, idle-minded curiosity."

For a short while, there was an 'industry' collecting specimens for marine aquaria that were kept in peoples' homes. Local fishermen could supplement their income by collecting marine life and putting it on the train to London. Those aquaria were difficult to maintain and their popularity short-lived.

Mine waste, china clay waste, sewage disposal and construction projects were all having impacts on marine life in the nineteenth and twentieth centuries but, perhaps, only causing concern when commercial interests (salmon fisheries and oyster fisheries in particular) were adversely affected. In the latter part of the twentieth century, oil pollution became a source of concern, expressed after the severe impacts of the *Torrey Canyon* wreck in March 1967. Then, along came scuba divers collecting shellfish and souvenirs such as sea urchins and sea fans to take the blame for declines in some marine life. No-one seemed to be considering the impacts of fishing and yet it was heavy mobile fishing gear that was not only damaging level sediments but was also destroying reefs of soft rock and the species living on them.

During the 1960s, the need to identify marine protected areas was being pursued in several parts of the world. In Britain, that imperative was being discussed from the mid-1960s and, in 1969, Lundy was being suggested as a location that should be established as a voluntary marine nature reserve (the history of the Lundy marine protected area is described by Hiscock and Irving, 2012). At about the same time, discussions were underway to establish a local nature reserve at Saltern Cove in South Devon with a boundary which extended to 2 m below Chart Datum level in order to protect its marine biological interest. Torbay Borough Council notified the reserve under Sections 19 and 21 of the National Parks and Access to the Countryside Act, 1949, in August 1973. The imperative for marine protected areas had taken-off but mainly through voluntary codes-of conduct. One such highly successful initiative was at Wembury in South Devon, where the Wembury Voluntary Marine Nature Reserve was established in1981.

Statutory protection

The Wildlife and Countryside Act 1981 (as amended) is considered the principle mechanism for protection of wildlife in Great Britain. It includes provisions for the establishment of Sites of Special Scientific Interest (SSSI) (intertidal out to the jurisdictional limit of local authorities, usually Mean Low Water level) and for the protection of certain species. It included provisions for the establishment of Marine Nature Reserves. The first (and only) one to be established in England was at Lundy, designated on 21st November 1986. Very few SSSI around England are established for or include marine biological interest in their citations. However, and most likely because of a long history of study and local marine biological knowledge, there are several that I interpret as having been established predominantly or in part for their marine biology. They are:

- Erme Estuary (estuarine habitats)
- Exe Estuary (mudflats and sandflats)
- Plymouth Sound shores and cliffs (rocky shores)
- Prawle Point to Start Point (rocky shores)
- Tamar-Tavy Estuary (intertidal and subtidal sediments and rock)
- Taw-Torridge Estuary (sandflats. mudflats, mussel beds, migratory fish)
- Wembury Point (rocky shores)
- Yealm Estuary (diverse intertidal habitats and species)

The Wildlife and Countryside Act includes annexes of species to be protected. There are few marine species (excluding birds) but those that are known to occur on the shore and seabed off Devon and are listed in Schedule 5 and are:

- Fan mussel *Atrina fragilis*
- Pink sea fan, *Eunicella verrucosa*
- Giant goby, *Gobius cobitis*
- Couch's goby, *Gobius couchi*
- Long snouted seahorse, *Hippocampus guttulatus*
- Short snouted seahorse, *Hippocampus hippocampus*

The provisions for Marine Nature Reserves in the Wildlife and Countryside Act were overtaken by the European Commission's Habitats Directive (Council Directive 92/43/EEC, 1992) and the UK legislation that implemented that directive to create Special Areas of Conservation (SAC). SAC off the coast of Devon are as follows (Fig. 22).

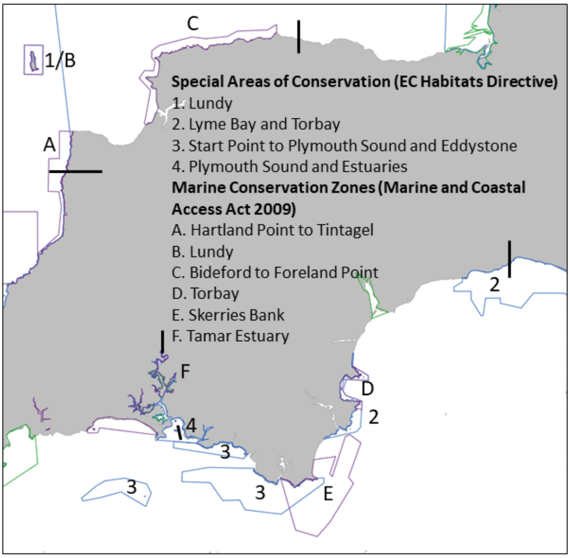

Figure 22. *The location of SAC (blue outlines) and MCZs (purple outlines) off Devon.*

Plymouth Sound and Estuaries: Primary Annex I Habitats for selection: Sandbanks which are slightly covered by seawater all of the time; Estuaries; Large shallow inlets and bays; Reefs. Annex 1 habitats present as a qualifying feature, but not a primary reason for selection of the site: Mudflats and sandflats not covered by seawater at low tide. Annex II species present as a qualifying feature but not a primary reason for site selection: Allis shad (*Alosa alosa*).

Lundy: Primary Annex I Habitats for selection: Reefs. Annex 1 habitats present as a qualifying feature, but not a primary reason for selection of the site: Sandbanks which are slightly covered by sea water all the time and Submerged or partially submerged sea caves. Annex II species present as a qualifying feature but not a primary reason for site selection: Atlantic grey seal *Halichoerus grypus*.

Lyme Bay and Torbay: Primary Annex I Habitats for selection: Reefs; Submerged or partially submerged sea caves. Two separated areas.

Start Point to Plymouth Sound and Eddystone: Primary Annex I Habitat for selection: Reefs). Three separated areas.

The Marine Conservation Zone (MCZ) designation is an outcome of the Marine and Coastal Access Act 2009 which, in part, is a response to the OSPAR Convention (the Convention on the Protection of the Marine Environment of the North-East Atlantic). The designated features in a particular MCZ are to represent the range of seabed habitats in a region and certain species and habitats that are listed as Features of Conservation Importance. Where a MCZ overlaps, or occurs within, a SAC, the habitats listed for protection are intended to include representative and 'special' habitats and species not covered by the SAC designation. The Lundy Marine Nature Reserve was 'converted' to a MCZ early in the process but a full MNR became a MCZ with the only designated feature: crawfish *Palinurus elephas*. The Lundy area remained a SAC. MCZs off the coast of Devon are as follows.

Bideford to Foreland Point: Designated for a wide range of representative habitats and for Fragile sponge and anthozoan communities on subtidal rocky habitats (Fig. 23); Honeycomb worm (*Sabellaria alveolata*) reefs; Pink sea-fan (*Eunicella verrucosa*); Spiny lobster (*Palinurus elephas*).

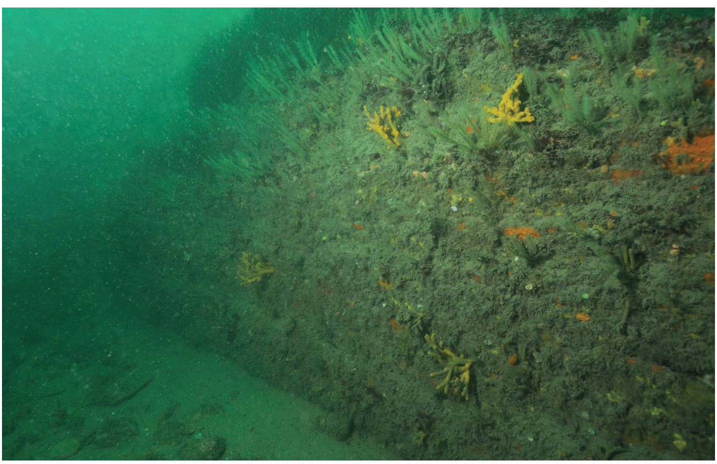

Figure 23. *A rock wall at Smallmouth between Ilfracombe and Combe Martin at a depth of about 4 m below Chart Datum. The wall and adjacent overhangs are characterised by long-lived and slow-growing branching sponges (*Axinella dissimilis*) and by cup corals with rarely occurring pink sea fans* Eunicella verrucosa. *The habitat 'Fragile sponge and anthozoan communities on subtidal rocky habitats' is one of the MCZ designated features. Image: Keith Hiscock, 15th July 2007.*

Lundy: Designated for Spiny lobster (*Palinurus elephas*).

Tamar Estuary: (various locations) Blue mussel (*Mytilus edulis*) beds, Native oyster (*Ostrea edulis*), and Smelt (*Osmerus eperlanus*)

Tor Bay: Designated for several representative features and for Long-snouted seahorse (*Hippocampus guttulatus*).

Skerries Bank: Designated for a wide range of representative habitats and for Spiny lobster (*Palinurus elephas*) and Pink sea fan (*Eunicella verrucosa*).

A full account of the features that are designated in SACs and MCZs is not given here but can be readily found on the Joint Nature Conservation Committee and Natural England websites which are kept up-to-date.

'Marine is different'

The nature conservation practitioner and policy advisors must not lose sight of the fact that marine biologists often have too little data to apply the quantitative criteria that identify Red List species and habitats and that were translated into criteria for Features of Conservation Importance in the MCZ process. The great majority of marine species and habitats emerge from application of criteria as 'data-deficient'. For those that do get through the screening process, the threatened habitats list is generally a meaningful list but the list of species is very incomplete. Whilst a few species do need protection from targeted collection or incidental damage, the great majority of species (including those that fall-out as data-deficient) should be protected by protecting their habitat.

Non-native species

Non-native species are a particular dilemma. They arrive attached to the hulls of ships, in the ballast water of ships and are mariculture species or accompany those species. Many, such as the leathery sea squirt *Styela clava,* are mostly present in low numbers and seem to 'fit-in'. Others, such as the slipper limpet *Crepidula fornicata* and the Pacific oyster *Magallana gigas* can become dominant (Fig. 24), changing the habitat and often displacing native species. There are estimated to be up to 100 non-native marine species that have colonised seabed habitats around Britain.

Figure 24. *Non-native Pacific oysters* Magallana gigas *now dominate areas of shore in the Yealm. They can be abundant as 'feral' individuals wherever there are oyster farms. Image: Keith Hiscock, 1st March 2017.*

'Biosecurity' measures are few and are often ignored. They include quarantine provisions for oysters that are moved from one location to another (with their hitch-hiking associated non-native species). They could include provisions for ensuring that vessels entering a harbour have a certificate of cleanliness.

Some see the arrival of non-native species as enriching our native fauna and flora but there is harm to commercial interests that can be done by pest species and there is the consideration that 'naturalness' is greatly valued in nature conservation. Best to stop them arriving in the first instance.

CONCLUSIONS

It has been impossible to describe the full range of habitats and species present around the Devonshire coast in this article, but I hope that the reader now has a better understanding of the richness and diversity of what, for most, is hidden from view. That hidden marine life is important in providing food, in giving enjoyment and for less visible services such as waste remediation. Ensuring that richness and diversity is maintained and that recovery is encouraged where damage has been done has become of high importance in recent years. At a time when our seas are changing, we need to keep studying what is where and understanding what are the activities and environmental factors that cause change. Management of human activities can then be undertaken to maintain and improve what we have.

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