SUBTIDAL COMMUNITIES WITHIN THE OUTER FLEET AND PORTLAND HARBOUR

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Introduction

The Fleet, the 14km long flooded interstice separating Chesil Bank from the impounded, former coastline conforms to the characteristics of a tidal lagoon. Marine exchange between this and the open sea is via a narrow entrance to the east, leading into Portland Harbour; whereas to the west, the lagoon is blinded-ended (Fig. 1). The very wave exposed and biologically barren outer flank of the storm beach contrasts with the sheltered conditions prevailing within the lagoon which have facilitated the development of rich and, to an extent unique, aquatic communities.

The Fleet can be subdivided into two components with contrasting physical characteristics (Dyrynda & Farnham, 1985). The eastern most 3km, which embodies two narrow sections, 'Smallmouth' and the 'Narrows', constitutes the lagoonal link channel (Figs 1 & 2). The original, natural entrance to the lagoon has long been artificially restricted by the construction of an embankment carrying the road to the Isle of Portland. Until late 1984, tidal exchange was confined to a narrow (50m) entrance, 'Smallmouth', passing through the north end of the embankment and spanned by the 'Ferrybridge'. During late 1984 a new entrance of comparable dimensions and spanned by a new bridge was constructed through the embankment approximately 100m south of the original. The old channel was infilled as the new one was opened such that tidal exchange was maintained throughout.

2km upstream of 'Smallmouth' is the 'Narrows', a 1000m section, uniformly approximately 50m wide, sandwiched between a promontory on the former coastline, and the storm beach. Recent papers on the hydrography of the Fleet by Whittaker (1981a), Robinson (1981, 1983) and Robinson *et al.* (1983) show that the link channel experiences a relatively normal tidal regime with a near full and regular cycle, but based on the very small, approximately 1.5m range characteristic of the Portland area. Good flushing combines with a relatively stable, polyhaline salinity regime, according to records not falling below 25% (Whittaker, 1981a; Robinson, 1981, 1983). Strong tidal currents are generated within the link channel, not only because it is the downstream section of the lagoon, but also a zone where flow is constricted, particularly within the 'Narrows' and at 'Smallmouth' where rapids form during spring tidal runs. A maximum tidal velocity of 4 knots has been recorded within the 'Narrows' (Whittaker, 1981a). The link channel is generally shallow, at less than 5m below chart-datum, and is floored by benthic substrates indicative of strong currents. Beds of gravel, stones and hard substrates characterise 'Smallmouth' and the 'Narrows', whereas sands predominate within the intervening section where currents are relatively weak. Hard substrates within the link channel support a rich epibenthic cover of macroalgae, particularly rhodophytes and phaeophytes, and of suspension feeding sessile invertebrates.

In contrast, the lagoonal basin experiences a reduced and more erratic tidal cycle and weak currents, concomitant poor flushing and more variable salinities (still generally polyhaline, only becoming mesohaline at the innermost section of the lagoon (Whittaker, 1981a; Robinson, 1981, 1983). Depths generally range from 3m below C.D. to much less and the prevailing epibenthic communities are meadows of seagrasses and (often floating) masses of chlorophytic algae (Whittaker, 1980, 1981b; Holmes, 1983).

Whittaker (1980, 1981a) first recognised the differences between the downstream and upstream sections of the lagoon, referring to these as the 'East' and 'West' Fleet respectively. The divide was set at the upstream end of 'Butterstreet Cove', 3km upstream to that separating the 'link channel' from the 'lagoonal basin' (Fig. 1). The classifications are compatible, differing only in emphasis. Whittaker (1980, 1981a) highlights the hydrographic and biological discontinuity at the west end of 'Butterstreet Cove', many species characteristic of the 'East Fleet', phasing out at that point (preliminary sampling of benthic at a series of stations along the lagoon during 1983 demonstrated the extinction of many rhodophytic algae and sponges at this location). However, from the viewpoint of the benthic substrate regime, a principle of the 1983 survey, the appropriate discontinuity is at the upstream end of the 'Narrows'. Beyond this point, coarse sediments and bedrock are soon replaced by fine sediments, and those more 'marine' species which do persist as far as Butterstreet, occur there only as free standing forms or as subsidiaries attached within seagrass beds.

Benthic macrobiological communities within the lagoon, particularly the lagoonal basin, have been investigated by members of the Fleet Study Group and others. The seasonal occurrences of sea grasses and chlorophytic algal masses were described by Whittaker (1980). Species inventories and distributions for the algae, ostracods and molluscs have been prepared by Burrows (1981), Whittaker (1981c) and Seaward (1980) respectively. During the summer of 1983, the Nature Conservancy Council commissioned two investigations of the subtidal benthos. Holmes (1983) reassessed the sea grass communities within the lagoonal basin, and Dyrynda (1984), assessed the distribution of benthic habitats and communities within the link channel, previously the least studied section of the lagoon. Aspects of the results of the latter survey are considered below and are reported more fully by Dyrynda (1984) and Dyrynda & Farnham (1985).

Channel bed substrates and communities were investigated by diving at a series of stations through the link channel zone and, for comparison, within Portland Harbour (Figs 1 & 2). Assessment procedures included in situ observation and recording, underwater photography, and the collection of quadrat samples of substrates and benthos for subsequent, detailed analysis. Although channel centre stations were concentrated upon, to construct a more comprehensive overall impression of the link channel, additional observations were made by long- and cross-channel dives. A species inventory was produced from the survey data.

In the absence of strong currents and wave exposure within the lagoonal basin, the load of suspended sediments generated there is small in comparison with more typical estuarine channels. Within the link channel, water clarity and light penetration are generally good, not only after the flood, but also after the ebb tides, and hence, infralittoral conditions (supporting macroalgal growth) prevail throughout the lagoon. High levels of nutrients and good water flow favour the flourishing of macroalgae and suspension feeding invertebrates alike, and both categories compete for substrate space, side by side, within the link-channel.

Communities

Community structure within the link channel varies primarily according to the strength of water currents, which govern not only the nature of substrates, but also the maximum sizes, and more significantly, drag factors, which benthic organisms can attain.

i) Community associated with stable hard substrates within the Narrows. (Stations 6-8) (Fig. 2)

The most species rich, highest biomass epibenthic community is associated with stable, hard substrates, of which the outcrops and boulders of corallian strata, which characterise the landward subtidal flank of the Narrows, constitute the major resource (Fig. 3). Illuminated faces of these support many 'high drag' erect algal forms such as Cystoseira nodicaulis and Laminaria saccharina. The brackish water sponge Halichondria bowerbanki occurs as a co-dominant upon illuminated faces of rock, growing as large mounds or plates up to 0.5m across, flattened in a plane perpendicular to the axis of flow. The sponge engulfs surrounding algae as it grows. Interstices within the resulting matrix are colonized by a multitude of smaller invertebrate species. Tube-dwelling forms, so anchored against current induced mobilization, are particularly common, e.g. the polychaete Platynereis dumerilii and the amphipod crustaceans, Jassa falcata and Corophium acherusicum. Although H. bowerbanki was the dominant invertebrate during summer 1983, more recent observations have revealed the hydroid Sertularia cupressina as a codominant during late winter and early spring. Cryptic (shaded) faces of rock support exceptionally large colonies of other sponges, e.g. Myxilla sp, Dysidea fragilis and Suberites massa, and in places, large numbers of the ascidians Phallusia mammillata and Ascidiella aspersa.

ii) Community associated with consolidated clay within the 'Narrows'. (Stations 7, 8)

Tracts of consolidated clay occurring between the corallian strata are maintained clear of superficial sediments only where the tides are strongest, i.e. particularly within the central 'Narrows', elsewhere being overlain by stones or gravel (Fig. 3). The crumbling clay surface supports the least species-rich, lowest biomass community. Such clay provides only a very poor anchorage for attached epibenthic colonizers, reflected in the sparseness and small size of the colonizing algae observed. Sporelings of larger, higher-drag forms such as Cystoseira and Fucus do colonize but are sloughed off before attaining an appreciable size. Only smaller, lower drag forms such as Chondria are able to successfully maintain occupancy through to reproduction. An interesting infaunal feature of the clay community within the central 'Narrows' is the presence of two species of boring bivalve, Barnea parva and the larger Barnea candida.

iii) Communities associated with the pebble regime within the 'Narrows'. (Stations 6, 7, 8)

The seaward half of the subtidal 'Narrows' is floored by the most landward extension of the storm beach (Fig. 3). Within the central zone, strong currents throw these pebbles into waves up to 1m in amplitude. Moving away from this area, the waves progressively decline, but are also developed upon pebble bars which have formed at each end of the 'Narrows'. The bars, it is believed, may be dominated by pebbles originally expelled by strong currents from the 'Narrows'. They also constrict tidal flow such that currents are increased locally within their vicinity.

During spring tidal runs, surface pebbles upon the waves within the central 'Narrows' may be exposed to currents sufficient for their mobilisation, even without any additional drag forces imposed by colonizing sessile biota. Surface pebbles that are colonized generally support low drag species. Seven thin encrusting algae and four species producing short, slender and hence low

drag shoots were found to colonize pebbles on the surface of the waves (Dyrynda & Farnham, 1985). The infralittoral anemone Anemonia viridis and herbivorous echinoderm Asterina gibbosa also feature. Strong currents maintain spaces between pebbles free of finer sediments to a significant depth, and sub-surface pebbles can be colonized by abrasion resistant suspension feeding sessile invertebrates such as the polychaete Pomatoceros lamarckii and the bryozoan Cryptosula pallasiana. A large and delicate polychaete, Polycirrus aurantiacus was also found to be common within sub-surface interstices.

Moving away from the central 'Narrows', larger, higher drag algae begin to feature on shallower pebble waves, including two rare species, i.e. Solieria chordalis and Gracilaria foliifera (W.F. Farnham, I.D. & pers. comm.). As algal cover increases, individuals on adjacent surface pebbles often intermesh to form a more continuous matting which adds stability to the pebble column. This facilitates colonization and persistence of still larger and higher drag algae such as Laminaria saccharina, Sargassum muticum and Chorda filum, or of the anemone Taelia felina.

The pebble bars at the ends of the 'Narrows' support local forests of large, higher drag Sargassum and Chorda plants. It is believed that a large proportion of these have been expelled from the rapids along with their pebble substrates by the stronger currents there. Since 1983, local forests of large Sargassum plants have also developed within the 'Narrows', but only within small embayments along the landward shore where currents are locally weak. In addition to these large macrophytes, the western (upstream) pebble bar contains an interesting interstial fauna which includes a population of the rare burrowing anemone Scolanthus callimorphus.

iv) Communities associated with sand. (Stations 4, 5)

Downstream to the Narrows, hard substrates and coarse sediments increasingly give way to sand supporting only a surface scattering of small hard substrates, mainly stones from the storm beach, or more occasionally, shells of the slipper limpet, Crepidula fornicata. The epibenthos colonizing small substrates within this less current scoured zone includes many higher drag forms including in particular, Sargassum muticum and Gracilaria verrucosa, but also Chorda filum, Laminaria saccharina, the ascidians, Phallusia mammillata (very common) and Ascidiella aspersa, and the anemones Cereus pedunculatus and Anemonia viridus. Sand, which predominates within the centre of the intervening section between the 'Narrows' and 'Smallmouth' (i.e. Station 4) is largely clear of small substrates and epibenthos.

v) The hard substrate community at Smallmouth. (Station 3)

The supports of the old 'Ferrybridge', constituted a local resource of shaded, stable hard substrates within 'Smallmouth', in effect, serving as an artificial cryptic infralittoral habitat. Locally strong currents favoured the development of a species rich cover of suspension feeding sessile invertebrates (Dyrynda, 1984). The flanks of this locally deepened section of channel were of clear sand, whereas the bed was of gravel with stones and boulders. The new Smallmouth entrance and bridge are in many ways similar to the old entrance, which may be reflected in the development of comparable communities in due course.

vi) Communities associated with deeper water mud within Portland Harbour. (Stations 2i, 2ii)

Sheltered conditions created by the construction of the very large breakwaters enclosing Portland Harbour have facilitated the formation of deep accumulations of soft muds within the deeper water, eastern sector of the Harbour basin. Dense populations of the sea pen Virgularia mirabilis were identified at stations within this sector (at depths approximating 10m below C.D.). Other burrowing forms recorded include two uncommon species, Scolanthus callimorphus (also see section iii), the red band fish Cepola rubescens and possibly the crab Goneplax angulata (requires confirmation). Common surface dwellers include the nudibranch mollusc Philine aperta, the anemone Sagartiogeton undatus and hermit crab Eupagurus bernhardus, the latter two both colonizing shells of Turritella communis.

vii) Community associated with the north entrance of Portland Harbour. (Station 1)

The current-scoured channel bed within the north entrance to Portland Harbour (channel centre depth, 12m below C.D.) supports a dense cover of Crepidula fornicata (approx. 3000 live and dead individuals per square metre recorded from quadrats). Many of the constituent Crepidula clusters are colonized by sessile invertebrates including Phallusia mammillata, Ascidiella aspersa, Suberites domuncula and Cereus pedunculatus.

Discussion

The 1983 survey identified the presence of unique habitats, communities, and rare species within the link channel, which adds to the overall conservation significance of the Fleet and Chesil Beach, already well established by previous studies (Ladle, 1981).

Within the subtidal zone of the link channel, the 'Narrows' is of particular interest. In common with other tidal rapids systems associated with land locked basins, e.g. Lough Ine and Mweeloon and Cashla Bays in Ireland, and Loch Sween in Scotland (Kitching et al., 1967; Ryland & Nelson-Smith, 1975; Lewis & Powell, 1958; respectively), the 'Narrows' suports species rich, high occupancy and high biomass benthic communities. However, whereas the hard substrata of the bedrock regime are generally typical of such systems, the pebble regime is very unusual. Such well rounded and large pebbles are a wave generated phenomenon, created on the outer flank of the storm beach, and only subsequently exported to the rapids where the contrasting conditions of minimal wave exposure, but strong exposure to tidal currents, prevail. A number of subtidal species which feature within the 'Narrows' are generally rare within the U.K. (Dyrynda & Farnham, 1985), including the algae Solieria chordalis and Gracilaria foliifera; the sponge Suberites massa; the anemone, Scolanthus callimorphus; and a goby, Gobius couchi. Other species, although more generally known, occur in exceptional abundances or sizes, e.g. sponges in general but particularly Halichondria bowerbanki, the anemone Anemonia viridis, the starfish Asterina gibbosa, and the ascidian Phallusia mammillata.

Two important alien (introduced) species occurring within the link channel, are capable of substantially altering its gross ecology. Whereas one, Crepidula fornicata (slipper limpet) is not realizing its full potential as a community dominant, the second, Sargassum muticum (Japanese seaweed) is having major effects.

Under favourable conditions, Crepidula fornicata, which is a superior

space competitor, proliferates to produce deep accumulations on any current scoured substrates ranging from sand to rock. Since the early part of this century, high-occupancy poulations have become established within many estuaries of southern Britain including the entrances to Poole and Langstone Harbours to the east (Dyrynda, 1985; Farnham, pers. comm., respectively), and locally, the entrance to Portland Harbour. Conditions within the link channel would appear to be favourable since Crepidula is not deterred either by shallow or brackish (even mesohaline) water (Dyrynda, 1985). Crepidula is present throughout the 'Narrows', but only at low densities. Any proliferation would devalue the conservation significance of this system by changing habitats and displacing other biota.

The second alien, Sargassum muticum (Japweed), is having a more profound effect (see Farnham, this vol.). First recorded in the Fleet in 1982 (W. Farnham, pers. comm.; Dyrynda & Farnham, 1985), this species is flourishing within the link channel under what appear to be very favourable conditions which include a vast resource of mobile small substrates, i.e. pebbles, which it prefers. In spite of attempts at clearance, quantities have increased substantially since 1983. Sargassum is undoubtedly changing the ecology of the link channel, most directly by displacing other biota. Chorda filum may be the most immediately affected since this is also a small substrate colonizer. During the 1983 survey, the two were often found together in mixed copses.

It is hoped that periodic re-evaluations of selected sampling stations within the link channel (which have recently commenced) will provide, by comparison against baseline data collected in 1983, further information on the changes that are taking place as the result of the introduction of aliens, and those which may follow more direct human interventions such as the restructuring of the entrance at 'Smallmouth'.

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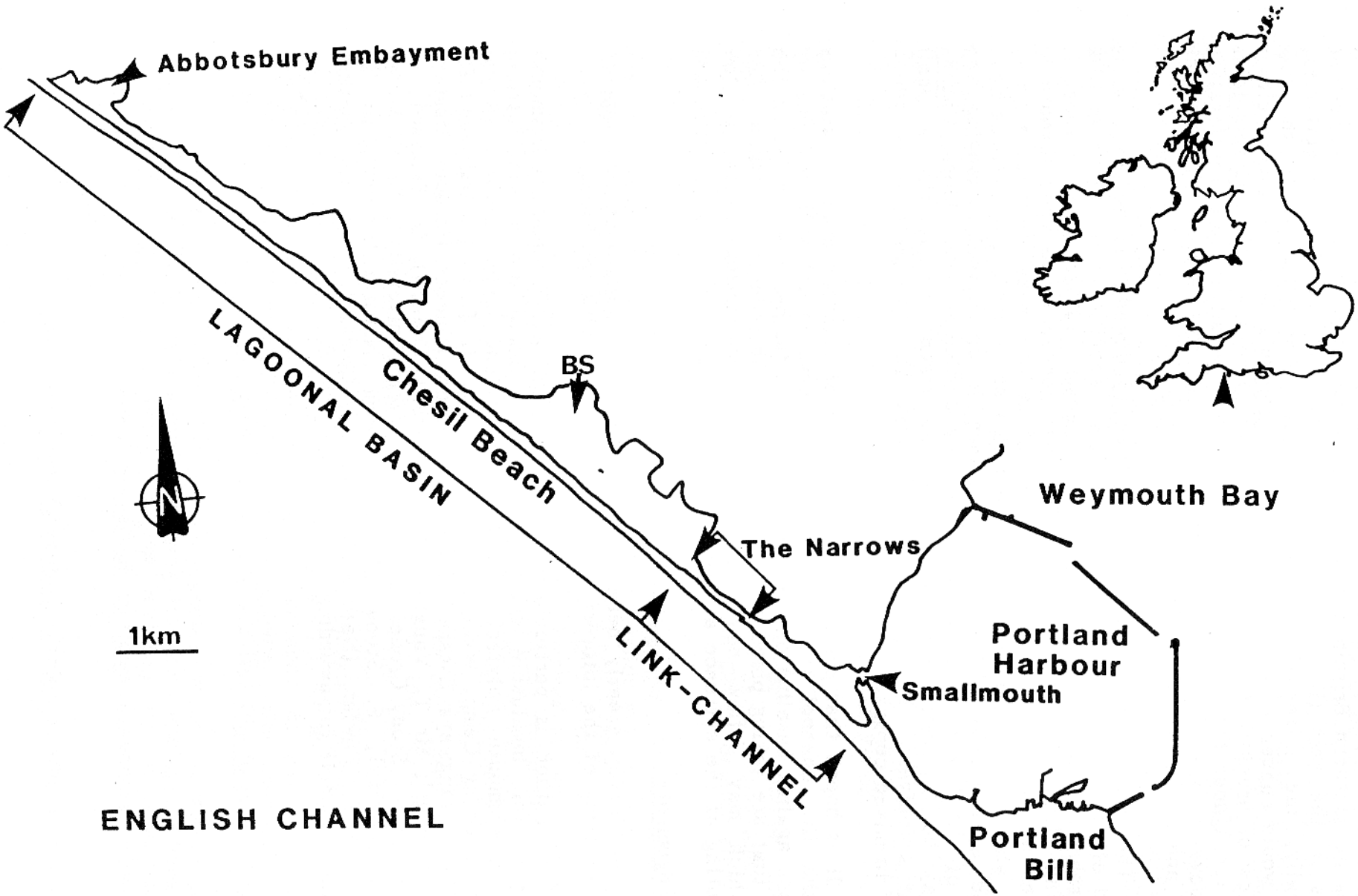

Figure 1. The Fleet Lagoon, and Portland Harbour.
(BS - Butterstreet)

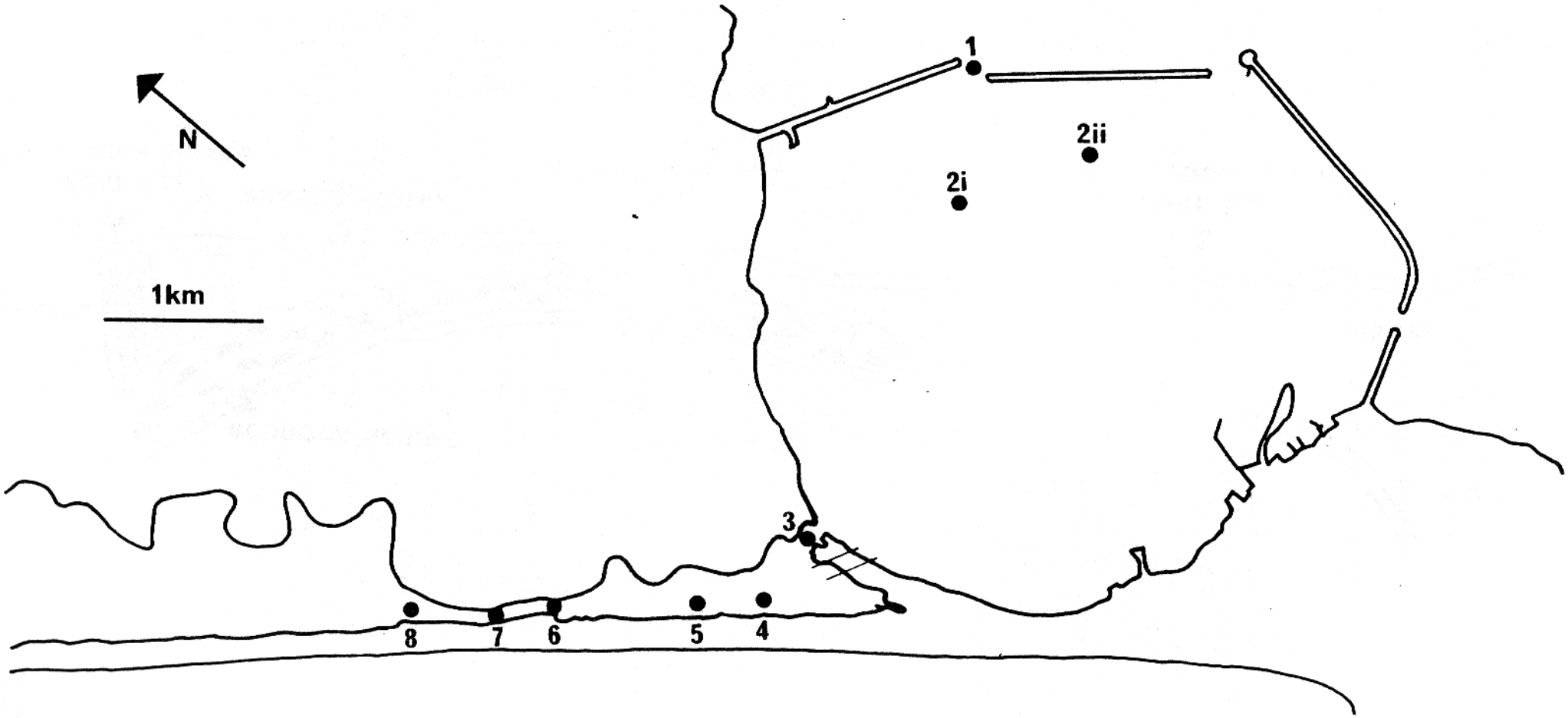

Figure 2. Dive survey stations within the link channel of the Fleet, and Portland Harbour. Stations were first surveyed during August and September, 1983. The path of the channel which replaced the old 'Smallmouth' in late 1984 is also indicated.

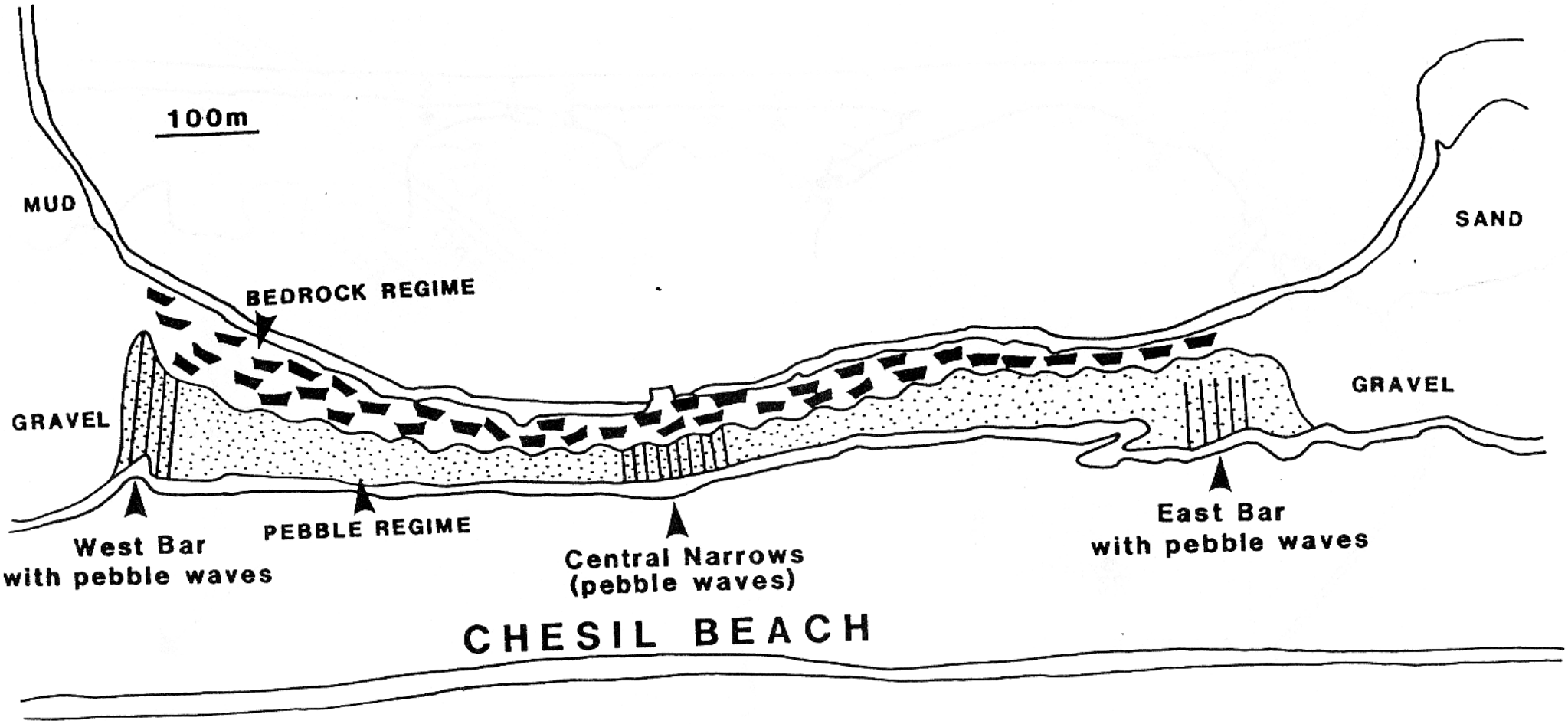

Figure 3. Diagrammatic representation of the distribution of seabed substrates within the 'Narrows', as compiled from diving investigations.
(after Dyrynda, 1984)