POOLE HARBOUR

ECOLOGICAL SENSITIVITY ANALYSIS OF THE SHORELINE

THE INSTITUTE OF TERRESTRIAL ECOLOGY

NATURAL ENVIRONMENT RESEARCH COUNCIL

Natural Environment Research Council

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POOLE HARBOUR: ECOLOGICAL SENSITIVITY ANALYSIS OF THE SHORELINE

A report prepared for BP Petroleum Development Ltd.

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COVER ILLUSTRATION
Waders feeding in winter at the edge of an evening tide, Sandbanks Bay, Poole Harbour (photograph by A J Gray).

All photographs by ITE (A J Gray, D E Stephens), except the aerial photograph on p.29 by Wessex Water Authority.

Acknowledgements

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The Institute of Terrestrial Ecology (ITE) was established in 1973, from the former Nature Conservancy's research stations and staff, joined later by the Institute of Tree Biology and the Culture Centre of Algae and Protozoa. ITE contributes to, and draws upon, the collective knowledge of the 14 sister institutes which make up the *Natural Environment Research Council*, spanning all the environmental sciences.

The Institute studies the factors determining the structure, composition and processes of land and freshwater systems, and of individual plant and animal species. It is developing a sounder scientific basis for predicting and modelling environmental trends arising from natural or man-made change. The results of this research are available to those responsible for the protection, management and wise use of our natural resources.

One quarter of ITE's work is research commissioned by customers, such as the Department of Environment, the European Economic Community, the Nature Conservancy Council and the Overseas Development Administration. The remainder is fundamental research supported by NERC.

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1 INTRODUCTION

1.1 The aims of the report

This report is concerned with the intertidal environment of Poole Harbour, Dorset. It provides an assessment of the relative sensitivity of different parts of that environment to damage by water-borne oil, using methods and criteria outlined in a later section (5). Only intertidal plants and animals are considered in detail. The possible effects of oilfield development on other intertidal aspects, eg recreation, or on adjacent environments such as heathland, are beyond the present remit. However, maps of the major land use of adjacent environments are included and, together with data on the ecology of the Harbour provided here and elsewhere, are intended to form a basis for oil-spill contingency planning.

For this reason, the report should be read in conjunction with other documents produced as part of an Environmental Impact Assessment (EIA) being conducted by BP in connection with their planned development of the Wytch Farm Oilfield. Both the EIA (to which the Institute of Terrestrial Ecology has already contributed data) and the work reported here have been commissioned by BP Petroleum Development Limited.

The core of the report is a series of 13 maps (6, p10-35), each covering a different section of the Harbour shoreline. They depict the major sediment and vegetation types, their relative sensitivity, their use by birds on a seasonal basis and the land use of areas above the tidal limit. A brief description is given of the major environmental features of each section. A composite ecological sensitivity map is provided at the end of the report (p36).

The maps are prefaced by an outline account of the ecology of the intertidal area (2), emphasising those features which contribute most to the variation in shoreline type and sensitivity. Brief descriptions of shoreline types (3) and of the use of the Harbour by birds (4) are followed by a discussion of the basis and limitations of the sensitivity analysis (5). It is important to study this last section before using the maps.

1.2 The study area

The modern landscape of Poole Harbour reflects its origin in Recent (Flandrian) times, when a post-glacial rise in sea level submerged the lower Poole Basin. The maximum extent of the marine transgression, reached

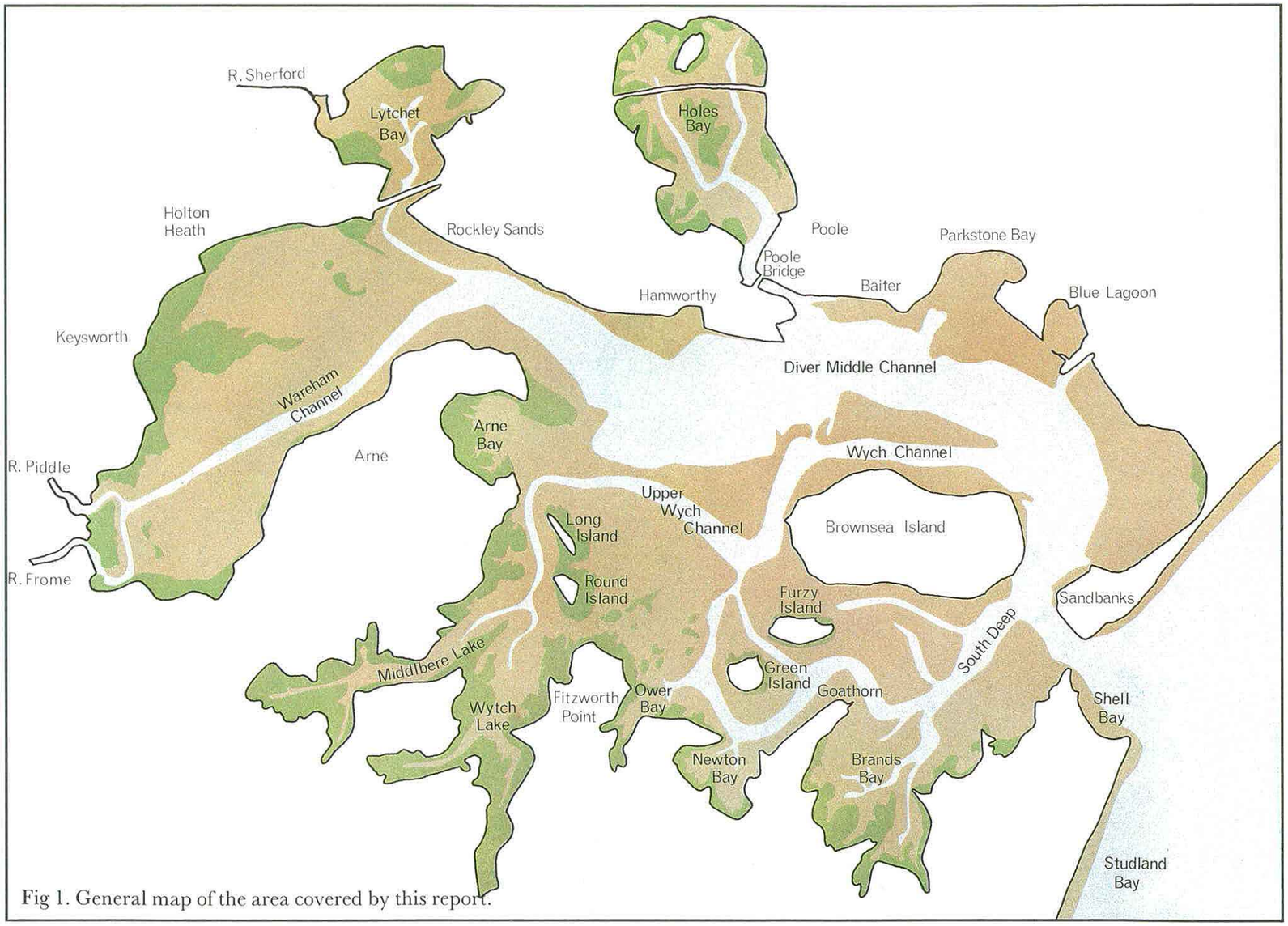


Fig 1. General map of the area covered by this report.

about 6000 years ago, is marked by a low bluff or by cliffs surrounding much of the Harbour above the present shoreline. The promontories and islands which remained above sea level form principal features of the modern Harbour (Figure 1). They have been modified during the last 6000 years by both natural sedimentary processes and artificial land reclamation. The former include the accumulation of sediments delivered to the Harbour by its rivers, the extensive growth of salt marsh vegetation, local cliff erosion and beach development, and the growth of sandspits at the Harbour mouth. Land reclamation has largely been associated with the development of the port and urban areas of Poole along the north shore (May 1969). The net result of these processes has been a reduction in the area of water at High Water Spring Tides – by more than 1000 hectares since 6000 BC to its present area of around 3600 hectares.

The principal rivers, the Frome and the Piddle, enter the Harbour from the west and drain the chalklands of Dorset. In the south, the Corfe River drains the Wealden sands and clays in the Isle of Purbeck, and the remaining rivers and streams, of which the Sherford River entering Lytchett Bay is the largest, drain the Eocene deposits surrounding the Harbour. The total

catchment exceeds 300 square miles. River-borne sediments have been derived mainly from alluvial flood plains, from the seams of pipe clay in the Bagshot Beds, and from the deposits of London Clay surrounding them. In more recent times, the amount of sediment transported in the rivers will have been affected by changes in land use. For example, it will be increased by converting water meadows to arable land or by military activities, but decreased by the extensive planting of conifers. Present-day sediment loads are thought to be relatively limited, confined mainly to periods of high run-off, and small compared to the redistribution of sediment following the recession of *Spartina* marsh (2). The rivers Frome and Piddle are also likely to be among the main sources of nutrient input to the Harbour, together with the final effluents from sewage treatment at Poole (Holes Bay), Lytchett Bay and Keysworth.

Except where they have been reclaimed for agriculture, afforestation or urban development, the Bagshot Sands fringing the Harbour and on the islands have developed a characteristic type of lowland heath. Humus-iron podzols are the predominant soil type, with gleyed podzols in some areas. Valleys on the heathland leading into the Harbour contain deposits of *Sphagnum* peat, and valley mires occur locally. Transitions from heathland to intertidal salt marsh occur at several points along the highly-indented southern shore line but, particularly in the west, such transitions have been modified by reclamation banks. To landward of these often ancient banks are grazing marshes and water meadows which, although modified in places by improved drainage and fertilizer application, form an integral part of the brackish marsh habitat (particularly that utilized by wading birds and wildfowl).

The diversity of vegetation types and the presence of large, representative, and undeveloped, areas of heathland along the southern shore is reflected in the statutory protection afforded much of it by nature conservation and other designations (see eg EIA Report Volume 1). By contrast, the northern shore has been considerably modified, transitions to semi-natural vegetation types occurring only in west Lytchett Bay and the north-western part of Holes Bay.

The Harbour entrance is marked by 2 low-lying sandy spits. Although their origins are poorly understood (Steers 1946; Robinson 1955; Kidson 1963), it is believed that they have developed towards each other by longshore drift, material being derived from the erosion of the Bournemouth cliffs to the north and both the outcrop of Tertiary cliffs and the bed of Studland Bay to the south. On South Haven Peninsula the redistributed Bagshot sands have developed a dune heathland vegetation, but the Sandbanks Spit has been extensively developed for recreational and residential purposes. The narrow Harbour mouth effectively prevents large-scale marine transport of sediments into the Harbour (the ebb current can reach 5 knots (2.6 m/sec) at Spring tides – Bird & Ranwell 1964).

2 THE INTERTIDAL AREA

2.1 The tidal regime

The intertidal area between extreme high and low water Spring tides comprises about 80% of the total area of the Harbour. It consists of sandflats, mudflats and marshes drained by a relatively stable system of creeks and channels. The pattern of low-water channels, with minor changes, is similar to that first surveyed 200 years ago. Three main systems can be distinguished: Wareham channel and its associated channels draining the upper Harbour and the north, the Wytch channel system draining the central southern area, and the South Deep draining the bays and flats south of Brownsea Island (Figure 1).

The relative stability of the channel system is clearly related to the constraining effects of the promontories and islands, which prevent the extensive lateral migration of low water channels characteristic of large estuaries such as the Dee or Morecambe Bay (Marker 1967; Kestner 1961; Gray 1972). Channel stability, and indeed the survival of the narrow inlet to the Harbour (Green 1940), also depends on the small tidal range.

Tidal range, and other features of the tidal regime of the Harbour are illustrated in Figure 2. Perhaps most notable is the double high water, a feature of tides along the coast from Portsmouth to Lulworth. The behaviour of the high water stand is rarely as smooth as depicted in Figure 2, the times and relative heights of the 2 high waters, particularly at neap tides, being readily affected by meteorological conditions. Variations in barometric pressure and wind strength and direction frequently produce departures from the pattern predicted under calm conditions – although the time of low water varies rather less from that predicted.

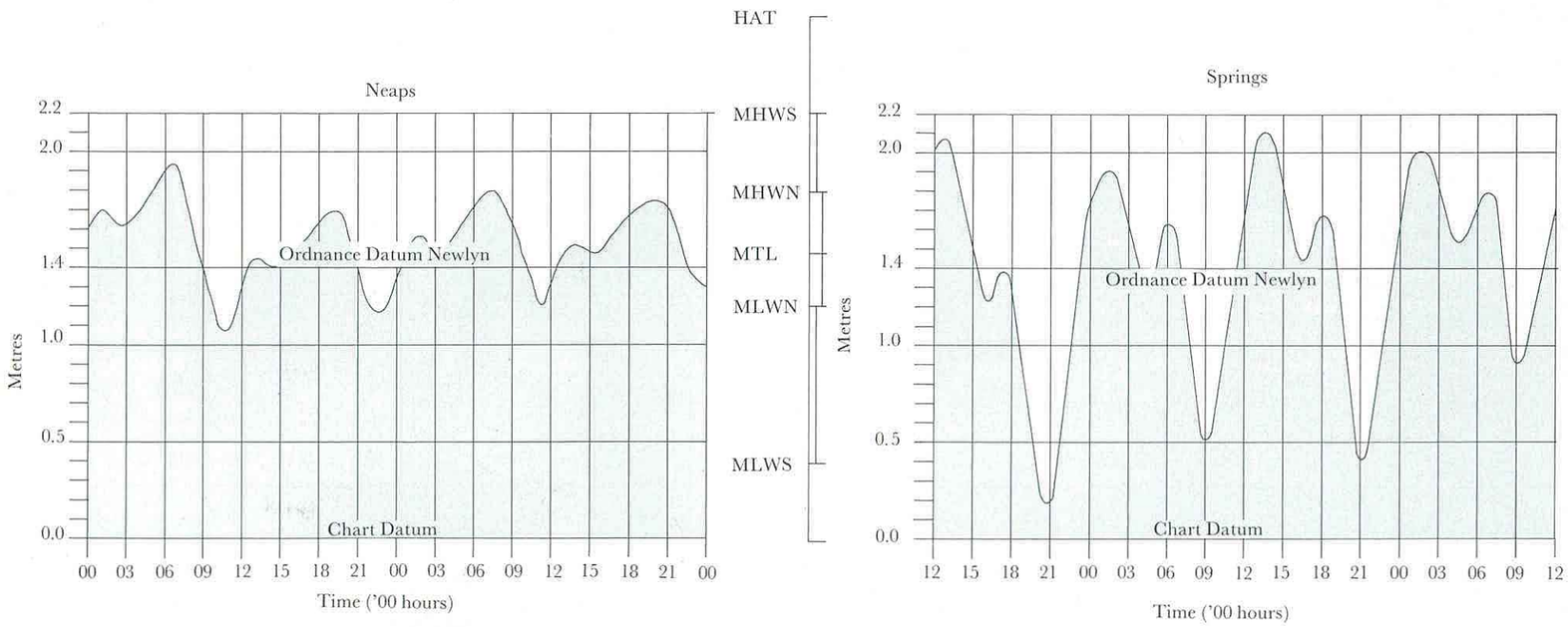


Fig 2. Typical Tidal Curves as recorded at Poole Bridge.

Notwithstanding such variations, the tide in the Harbour is above Mean Level (which is slightly above O D Newlyn) from about 2 hours after Low Water to about 2 hours before the next Low Water. Coupled with the small tidal range (approximately 1.8 m at Springs and 0.6 m at neaps) the presence of water above Mean Tide Level for around 16 out of 24 hours imparts a lagoon-like characteristic to the Harbour and its shoreline. This has several important ecological consequences.

First, the fringe of salt marshes is confined vertically to a relatively narrow band at the top of the tidal range. The lower limit of *Spartina anglica* is at about +0.05 m OD, and the Highest Astronomical Tide (for 1985) at +1.30 m OD. The lower *Spartina* limit, near Mean Tide Level (see Figure 2), was estimated by Ranwell *et al.* (1964) who comment on the remarkable implication that, at that time, some *Spartina* marshes must have experienced about 5800 hours of tidal submergence per year, including, in areas such as Arne Bay, several periods of more than 9 hours of continuous submergence. Hubbard's reassessment of the Poole tidal data, revealing periods of more than 23 hours of continuous submergence, suggested that tidal submergence was not solely responsible for limiting the seaward spread of *Spartina*, an assertion backed by experimental evidence (Hubbard 1969). The notion that mechanical factors, especially the physical effect of wind-generated waves at High Water, are important in limiting salt marsh spread is supported by the general disposition of salt marsh and other intertidal sediments. Salt marsh is largely confined to the more sheltered bays and inlets, and areas of erosion are commonly found opposite the longest wave fetch, particularly from the prevailing wind direction (the south-west). Sediments thus eroded at high tide level are often redistributed locally, the growth of sand and shingle spits being associated with nearby cliff erosion (eg on Brownsea Island, Furzey Island, in the north Arne area, and at Shipstal Point).

Second, because it results in a relatively short exposure time of the inter-tidal flats, the tidal regime limits the availability of invertebrates to their bird predators, chiefly waders. The tide level depicted in Figure 1 is a relatively rare event! More often, waders find their feeding grounds submerged. Indeed, the difficulties they face in obtaining food may be exacerbated by meteorological conditions which can lead to the feeding areas remaining submerged throughout several tidal cycles. Thus, the tidal regime is likely to be a major factor limiting the numbers of waders using the Harbour during the winter months. Studies of the ways in which those birds present utilize such a reduced and unpredictable food resource would provide important insights into the likely impact of development within the Harbour (see 4).

Third, the relatively poor flushing characteristics of the Harbour have enabled it historically to act as a 'settling tank' in which sediments of fluvial origin have accumulated. This is reflected in a general gradient of sediment types from the silts and clays of the upper Wareham channel to sands and gravels near the Harbour mouth (3). Poor flushing characteristics will also enable nutrients and pollutants discharged into the upper Harbour to reside longer within the Harbour than is the case in high-energy estuaries such as the Severn or Morecambe Bay.

2.2 *Spartina*

Changes in the intertidal area of Poole Harbour this century have been dominated by the arrival, spread and decline of the grass *Spartina anglica*. First recorded from the Harbour around 1890 (at Ower) this remarkable species spread rapidly and was widely planted. By 1924 it covered more than 775 ha of intertidal mudflat. Stratigraphical studies (Bird & Ranwell 1964; Ranwell 1964; Hubbard & Stebbings 1967) have indicated that the general marsh level was raised in some areas of the upper Harbour by more than 180 cm, and that *Spartina*-accreted sediment depths of more than a metre are common, with a possible gradient to shallower sediments towards the Harbour mouth.

Poole Harbour in general, and Arne Bay in particular, were the major source of plants and seeds of *Spartina* exported to other parts of the British coast and around the world. Between 1924 and 1936 alone, more than 175 000 plant fragments were sent to over 130 sites (Hubbard 1965).

In the mid 1920s, the *Spartina*-dominated marshland began to recede from many parts of the Harbour (although it was still spreading in other parts). The loss of marshland has become particularly noticeable in recent years in areas such as Holes Bay and the south-east corner, but detailed studies indicate that the rate of recession has accelerated only slightly within the Harbour as a whole (Gray & Pearson 1983, 1984). By 1980 around 360 hectares, more than 46% of the 1924 area, had been lost, 189 hectares since 1952. In the last 30 years more than 100 ha, approximately two-thirds of the 1952 area, has been lost from the south shore eastwards of Fitzworth Point and south of Brownsea Island. The loss of marsh from the lower Harbour is relatively recent. *Spartina* was present on Soldier Ground, north of Brownsea Island, as late as 1938 (Green *et al.* 1952), and was actively invading parts of the south-east shore in the 1950s.

The spread and subsequent decline of *Spartina* in the Harbour has thus been on a major scale (in areal terms it is equivalent to the growth of around 1100 football pitches and the later loss of more than 500 football pitches!). It has been accompanied by large-scale physiographic and sedimentary changes and these are reflected in bed-level fluctuations in several of the major channels. The general deepening of the channels between the hydrographic surveys of 1849 and 1934 occurred during the entrapment of large volumes of formerly mobile sediments as *Spartina* spread rapidly from the 1890s onwards.

Between 1934 and 1954 there was considerable shallowing of most major channels, presumably as sediment was released from the marshes, now in widespread recession. Although shallowing continues today in parts of the upper estuary (eg the upper Wytch channel) – the seaward end of most major channels has deepened during the past 30 years. Extensive recent scouring in the lower Harbour (possibly related to an increase in tidal volume in the Harbour as mudflat levels were lowered during marsh loss) is evident along much of the shoreline.

The changes in *Spartina* marsh in the Harbour underline the importance, in attempting to assess the sensitivity of present shorelines, of taking into account the pace and scale of the physical and biological changes which may occur within the intertidal environment.

3 SHORELINE TYPES

Poole Harbour contains a great variety of shorelines ranging from reed- and marsh-covered mudflats to sandflats and shingle beaches. Indeed, if the dunes at the Harbour mouth and the chalk cliffs to the south are included, most types of British coastal habitat are represented within a relatively small area.

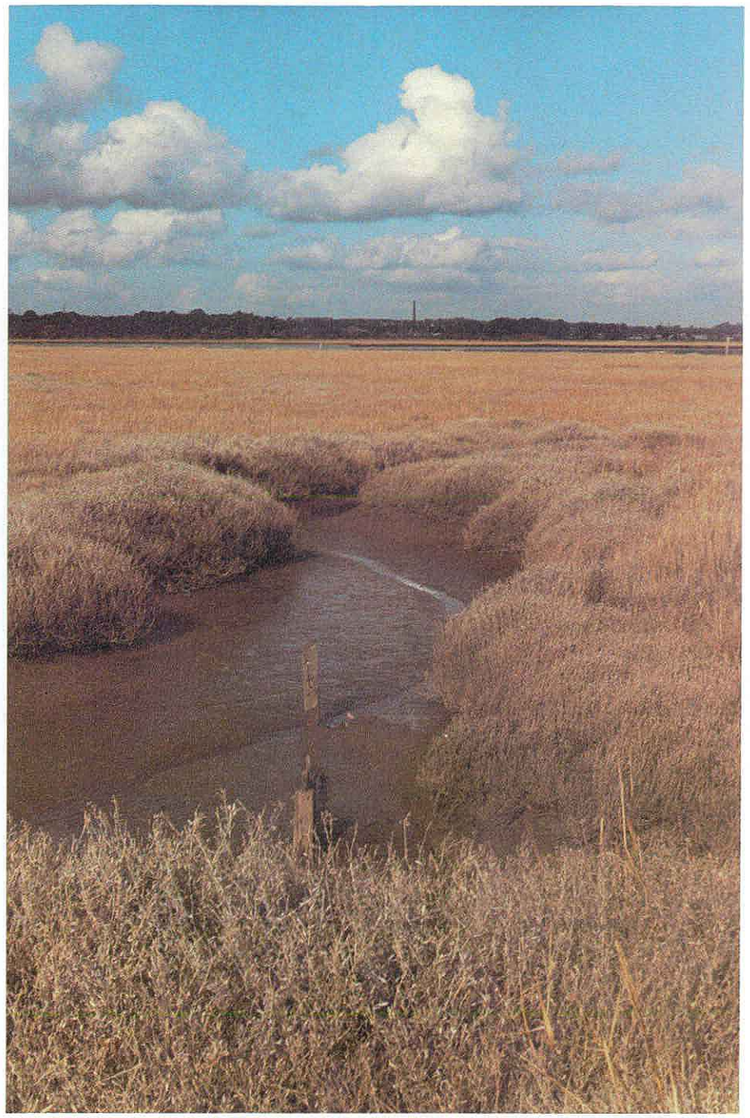
For the purposes of the present survey, and of this report, it was necessary to characterise this variety in a relatively simple way. Furthermore, the period available for fieldwork did not allow either a comprehensive analysis of sediment particle-size distribution or a complete classification of the plant communities. However, it was possible to compare a simple classification of both sediment and vegetation types with some earlier work – in the case of sediment types with a particle-size analysis which formed part of a benthic invertebrate survey in the period 1970-75 (unpublished data held by ITE of work by Stubbings, Arnold, Anderson, Allen, Ranwell and McGrorty for the Nature Conservancy), and in the case of vegetation, with more recent studies of the Harbour salt marshes (Gray & Pearson 1983, 1984; and unpublished data of Gray, Coyte and Myers).

3.1 Unvegetated beaches and flats

Within the Harbour 6 major categories of beach material were distinguished: mud, sandy mud, muddy sand, sand, shingle and boulders. The first 4 types are very broad textural classifications for the sediments below the coarse sand fraction (below 1 mm average grain size or above 0 ϕ) and generally occurred as intertidal flats. They included areas of silts and clays (<63 micron particle size), of coarse sands, and of sediments intermediate to these which could be crudely distinguished in the field by rubbing between the fingers, and by their general texture. Some coarser sands (up to 2 mm) occurred on shelving beaches.

The category 'shingle' includes both true shingle beaches composed largely of pebbles at about high tide level, and also gravel beaches and spits in which pebbles occur in a matrix of finer material, often extending down to low tide. As noted earlier, the pebbles largely originate from the Bagshot Beds and the Pleistocene gravels which cap these, whereas most of the larger cobbles and boulders strewn on the upper beaches, particularly the boulders more than 200 m in diameter, are Purbeck limestone derived from nearby sea walls and breakwaters.

The distribution of these sediment types is shown in detail on each of the 13 maps in 6. The text accompanying these maps also indicates some features of possible importance to oil-spill planning such as the firmness of the substrates. Where they were evident at the time of survey, notes were made on the obvious benthic organisms, eg *Arenicola* casts, and on the presence of marine algae, but it should be emphasised that these observations were unsystematic. Evidence of bait digging was noted.



In general the finer sediments occur, as expected, in the upper Harbour and in the sheltered bays and inlets. The upper Wareham Channel and Holes Bay are 2 areas where well-sorted silts and clays produce very soft mudflats. Along the middle section of the northern shore, from Hamworthy to Baiter, and in the south around Arne, are found poorly sorted gravel beaches, sometimes with pebbles in a matrix of mud. Towards the Harbour mouth a very wide range of sediment types occurs but these are dominated by the coarser fractions including sands and shingles. The local variation which occurs within these broad divisions can be seen on the maps.

3.2 Salt marshes

The intertidal areas covered by flowering plants have been investigated in rather more detail. For example, 8 different vegetation types were recognised on the basis of a detailed survey of Holes Bay, an area in some respects floristically impoverished (Gray & Pearson 1983). For the purposes of this report, however, the plant communities have been grouped into 3 major categories: *Spartina* marsh, upper salt marsh and reeds.

'Spartina' marsh includes salt marshes which consist entirely of *Spartina anglica* or are dominated by this species. In many areas, particularly to the west of Fitzworth Point, there are gradual transitions from this type of marsh to one in which *Spartina* is only a minor component. Among the species which have commonly invaded *Spartina* marshes are *Halimione portulacoides*, *Puccinellia maritima* and, in the upper estuary, *Phragmites australis* and *Elymus pycnanthus*. As indicated in 2.2, the *Spartina* marshes are undergoing considerable change. The lower limits of these marshes tend to be around +0.05 m OD (extremes down to +0.15 m) with an upper limit around +0.9 m.

The 'upper salt marsh' is a rather broad category of vegetation type containing at least 3 recognisably different communities. The most seaward of these is generally dominated by *Plantago maritima* but may contain many species. A second type are the brackish rush communities dominated by *Juncus maritimus, J. gerardii* or *Scirpus maritimus*, which may become very rich in species, particularly where transitions to unimproved grazing marsh occur. A third, rather uniform, type of salt marsh develops on the locally better drained areas and is usually characterised by *Elymus pycnanthus*.

Finally, areas of dense *Phragmites australis* comprise a floristically and structurally different type of brackish marsh (limited to chlorinities below 1.2%).

The presence of other vegetation types, eg vegetated shingle, and transitions to predominantly terrestrial communities, such as carr, dunes or heathland, although not mapped, are noted in the text surrounding the maps.

4 BIRDS

Perhaps the animals most obviously and immediately affected by water-borne oil, and around which most public concern has centred following past oil-spills, are the birds. Clearly, any attempt to assess the relative sensitivity of different shorelines to oil should consider the extent to which they are used by birds. Ideally, it should incorporate some measure of the numbers of birds of all species using each area, the relative 'conservation value' of each species, and the relative susceptibility of those species to oil damage. In practice, all 3 aspects are difficult to measure. Each is considered separately below.

4.1 Numbers and distribution

The ornithological interest of the Harbour is focused on its populations of overwintering waders and wildfowl. Since 1969, the Dorset Bird Club has made monthly counts of these groups as part of the BTO/RSPB/WT 'Birds of Estuaries Enquiry' (Prater 1981). These data, kindly made available to us by Dr D J Godfrey, are the main source for this analysis. They have been augmented by recent studies (Goss-Custard & Durell 1983, 1984; Bromby 1983; Harvey & Bradford 1984), by references to local bird reports of the Dorset Natural History and Archaeological Society, 1976-82, by discussion with local reserve wardens, and by some limited fieldwork aimed at covering the more serious gaps in our knowledge (eg the area off Keysworth, sizes and sites of gull roosts (Durell, unpublished data)).

Counting birds in an area like Poole Harbour is extremely difficult. The highly indented shoreline, about 84 km (52 miles) plus a further 15 km (9.25 miles) around the islands, presents considerable logistic problems. Synchronising counts and following bird movements in the inaccessible areas are difficult. Many factors influence the distribution of waders and wildfowl including food supply, meteorological conditions and the state of the tide. Thus, counts made on a particular day each month, irrespective of tidal conditions, may be misleading.

Instead of using monthly means, therefore, the analysis presented here is based on the highest 10 counts made in each month in each area of the Harbour during the period 1969-83. This figure is likely to provide an over-estimate of the average population size of each species but this is unimportant in view of the immediate objective. Calculating average population sizes or allowing for errors caused by counting birds more than once (eg in adjacent areas) is less important than some

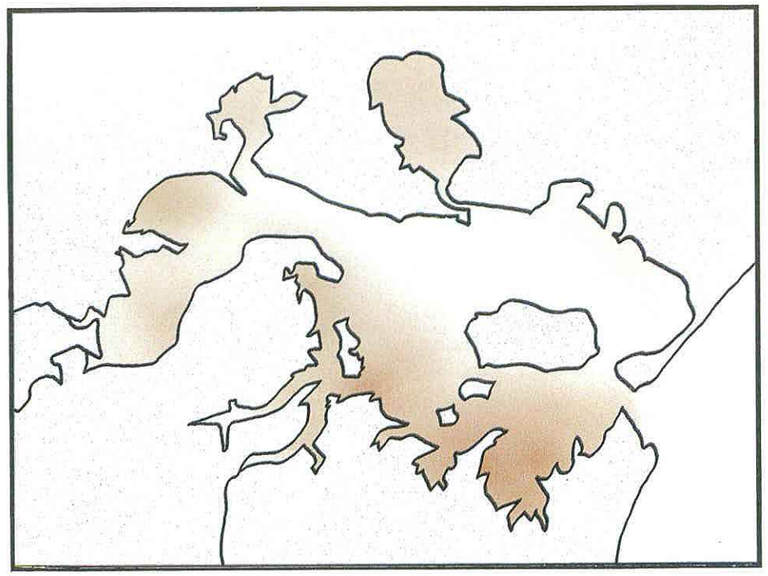


Fig 3. General distribution of shelduck.

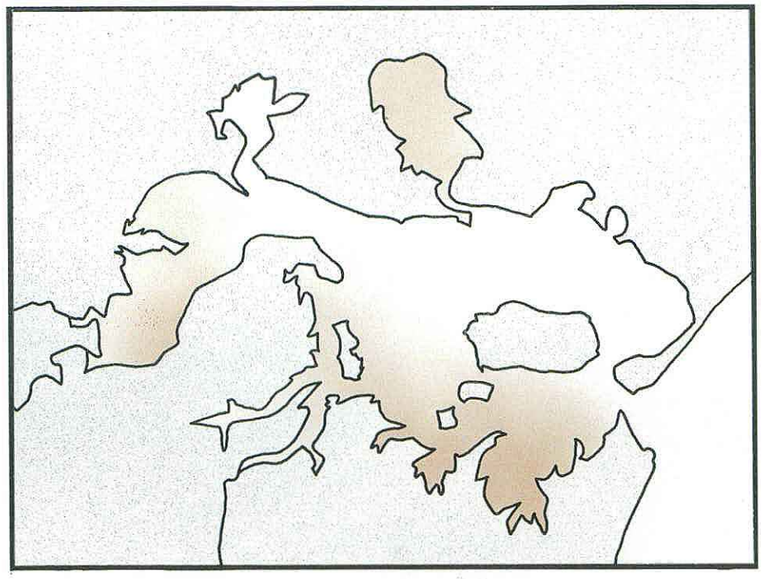


Fig 4. General distribution of black-tailed godwit.

estimate of the maximum number of birds which could be in a particular area (and potentially oiled) at any one time.

To enable general comparisons to be made between areas, the birds have been divided into 3 main groups according to their pattern of use of the Harbour. These groups, plus other species of interest, are considered separately in 6.

4.1.1 Intertidal birds

The first group, containing most species, includes all birds which feed on the intertidal flats or marshes at low water, and roost or feed around the edge of the Harbour at high water. These are labelled 'Intertidal' birds in 6. They include all the wader species, except lapwing, and, among the wildfowl, mallard, teal, wigeon, pintail, shelduck, Brent goose and mute swan. Many of these birds roost in the lagoon on Brownsea Island, with waders also roosting at Arne and Studland and ducks roosting at Little Sea and Poole Park.

Individual species, of course, have different distributions over the intertidal feeding grounds. The 2 species whose distributions are illustrated in Figures 3 and 4, shelduck and black-tailed godwit, (conservationally, the most important species – see 4.2) have rather similar density patterns – reflecting their preference for the invertebrates which occur in muddier areas. Other intertidal species have very different distribution patterns. For example, bar-tailed godwit concentrate in the sandier areas around Sandbanks and near the Harbour mouth, ringed plover are most common along the north shore, especially the area around Parkstone, spotted redshank prefer the upper Harbour, especially the Wytch and Middlebere channels, and so on.

There is also considerable variation between species in their temporal use of the Harbour – although the 4 winter months, November-February, are the most important over all. For example, oystercatcher numbers remain high from August to February, ringed plover numbers peak in August/September, grey plover show a distinct peak in February, and so on.

The pie diagrams of intertidal birds in 6 disguise this variation in the temporal and spatial use of the Harbour by different species. Their shape is influenced in many areas by the numbers of dunlin, the most numerous species (hence the frequency of February peaks). Nevertheless, they provide a means of comparing different areas of the Harbour on a month-by-month basis in terms of the total numbers of birds likely to be found there irrespective of species.

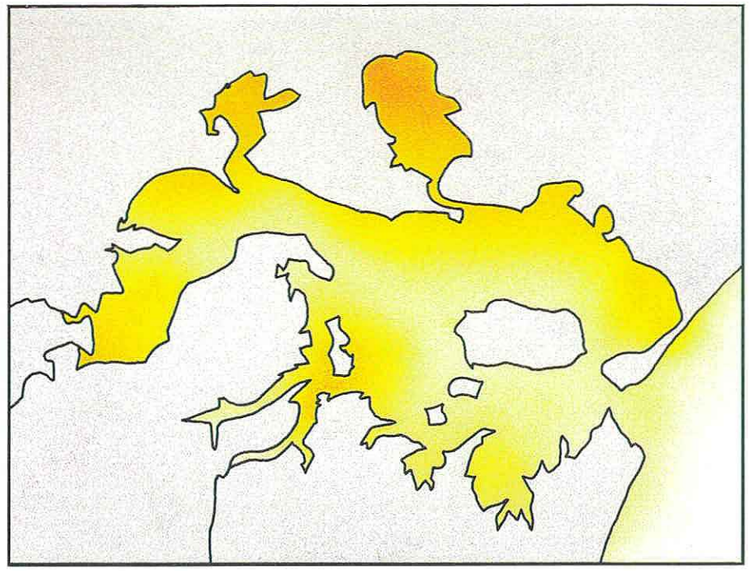


Fig 5. General distribution of black-headed gull.

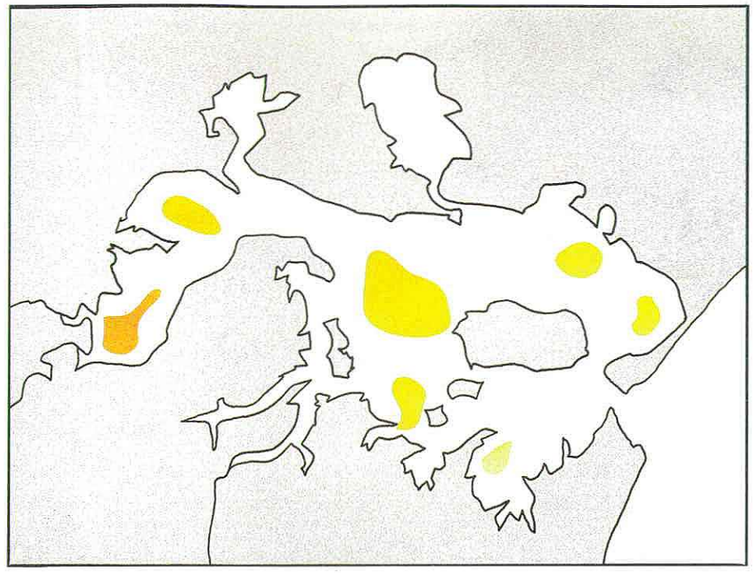


Fig 6. Major gull roosts November 1984.

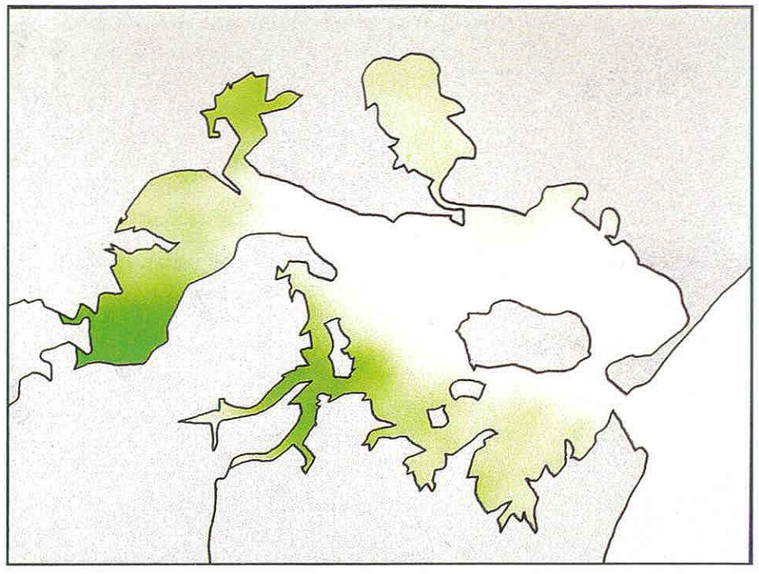


Fig 8. General distribution of lapwing.

4.1.2. Gulls

The second group of birds which occur in the Harbour in large numbers are the gulls. They are found at both low and high water, feeding and roosting on the mudflats and on the water. Numerically they are dominated by black-headed gulls, the concentrations of which along the north shore, especially in Holes Bay and Lytchett Bay, (Figure 5) reflect their attraction to urban areas, waste tips, and sewage outfalls. They are present in large numbers throughout the year, nesting on the salt marshes in colonies whose locations change under the pressures of predation. The highest numbers occur in February, hence the common peak in the total gull figures in that month in most areas.

Gulls, and again predominantly black-headed gulls, also roost in the Harbour at night, coming together in large numbers from the surrounding countryside at what are often traditional roosting sites. The position and density of the major night-time roosts as determined by a survey in November 1984 (Durell, unpublished data) are illustrated in Figure 6. (Actual numbers are given in the text accompanying the maps.)

4.1.3 Diving birds

A third group of birds typically feed in the Harbour at high water and in the deeper channels or at sea during low water. This group includes the cormorant, goldeneye, great crested grebe and red-breasted merganser (the distribution map of which is shown in Figure 7). Terns, which are not overwintering birds but

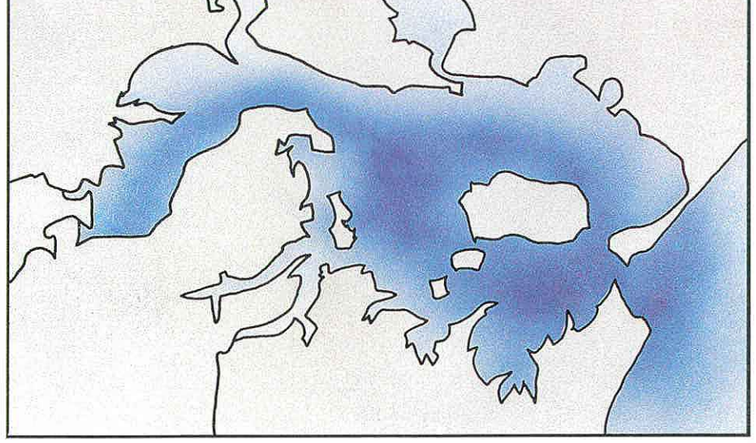


Fig 7. General distribution of red-breasted merganser.

nest on Brownsea Island, are included in this group. All these birds are fish eaters.

4.1.4 Other species

Other species which largely feed outside the intertidal area will sometimes roost or feed in the Harbour. These include birds which feed mainly in the fields such as lapwing (Figure 8) or Canada goose, and also waterfowl such as scaup, shoveler, tufted duck, pochard, gadwall and moorhen which feed mainly on nearby lakes and ponds (notably Little Sea, Brownsea and Poole Park). Where such birds are concentrated in a particular area, and may occasionally encounter water-borne oil within the Harbour, they are mentioned in the text, and seasonal variation in the numbers of the most important species depicted.

4.2 Conservation value

By considering only the total numbers of birds in each part of the Harbour, regardless of species, we are ignoring variation in the perceived 'conservation value' of different species. Avocets have arguably more public appeal than gulls, and red-breasted mergansers more appeal than cormorants. They are also, in both cases, rarer. In fact, it is the relative rarity of species which provides the only objective measure of conservation value. More specifically, the criterion applied to each species is the proportion which the local population of that species represents of the estimated British, and West European, populations. Where this proportion exceeds 1% of these populations, the species is deemed to be of national or international importance respectively.

In Poole Harbour, the populations of 2 species exceed the international 1% figure: shelduck and black-tailed godwit. Prater (1981) lists a further 7 species whose numbers exceed the national 1% figure: redshank, ruff, teal, pintail, shoveler, red-breasted merganser, and Canada goose. Consideration of the 10 highest counts, as in this analysis, would also add ringed plover, grey plover, curlew, spotted redshank, greenshank,

cormorant, gadwall and Brent goose to the list of species reaching the national 1% level (but see Prater 1981 p128).

These measures provide a means of weighting the sensitivity assessment to account for the relative 'importance' of different species (see 5).

4.3 Susceptibility to oil

Species vary in their susceptibility to oil pollution. Past incidents, including those in the Harbour (Ranwell & Hewett 1964), have indicated that diving birds, which often attempt to escape water-borne oil by diving and resurfacing elsewhere, are especially prone to become heavily oiled. In the 1961 Poole oil spill divers, great-crested grebes and red-breasted mergansers were particularly badly affected.

Gulls are likely to be most susceptible when roosting in vast rafts at night-time, but less affected when scattered over their feeding grounds. Partly oiled birds may, however, disperse over a very wide area making clean-up difficult. Among the intertidal birds those with alternative feeding areas, such as nearby fields, will be less affected, for example, than those which feed habitually at the tide edge, or even (as Brent goose and some long-billed waders) in shallow water.

The factors influencing susceptibility are poorly understood and it has not been possible to incorporate variation in susceptibility into this assessment of shoreline sensitivity. In particular the sensitivity of a certain shoreline has been assessed without regard to the diving birds which may feed in the major channels to seaward of it (and through which oil might pass on its way to the shore). Clearly these aspects need to be considered during oil-spill contingency planning.

5 ECOLOGICAL SENSITIVITY ASSESSMENT

5.1 Methods

The shorelines and intertidal area of the Harbour were surveyed at times of Low Water Spring Tides and classified according to the types outlined in 3. This field survey was combined with a study of recent aerial photographs to produce the maps which follow. In turn, the maps, together with data on birds (4), have formed the basis of the ecological sensitivity assessment.

Assessment of the relative sensitivity of different shorelines and intertidal areas to water-borne oil was based on a modification of the original method of Gundlach and Hayes (1978). This method attempts to integrate physical properties such as sediment type and wave energy levels with biological characteristics. It recognises the generally increasing vulnerability to oil-spill damage of increasingly sheltered, and hence usually muddier, shorelines. It has been modified in the light of experience (Hayes *et al.* 1980; Gundlach *et al.* 1981), especially where the biological sensitivity of intertidal flats has been shown by particular incidents to be greater than would be predicted from sediment type and energy levels alone.

Hayes *et al.* (1980) presently recognise 10 categories of shoreline in order of increasing vulnerability, from exposed rocky headlands to sheltered salt marshes. These are as follows:

1. *Exposed rocky headlands* where wave action keeps most oil offshore and biomass is often low.
2. *Eroding wave-cut platforms* from which oil is usually removed quickly by waves.
3. *Fine-grained sand beaches* into which most oil does not penetrate far, from which it can be removed mechanically and where recovery (of, say, amphipods) may occur relatively quickly.
4. *Medium- and coarse-grained beaches* where oil may penetrate, making cleaning difficult, but may be removed naturally within months.
5. *Mixed sand and gravel beaches* which oil may penetrate rapidly and where it may persist for long periods.
6. *Gravel beaches* into which oil penetrates most deeply and may persist, but where the biomass is often low.
7. *Exposed compacted tidal flats* which oil does not readily penetrate but where, as established by the Amoco Cadiz oil spill, biological damage may be extensive.
8. *Sheltered rocky coasts* where oil may persist for many years in what is often a biologically-rich shoreline type.
9. *Sheltered estuarine tidal flats* which are vulnerable areas of high biomass and diversity and where long-term persistent oil may prevent re-colonization by some species.
10. *Sheltered salt marshes*, the biologically most productive type, where oil may have very damaging and persistent effects.

Two important considerations have been made in applying this type of vulnerability index to Poole Harbour.

First, it is clear that most of the intertidal area within the Harbour can be classified as categories 9 or 10, the two most vulnerable shoreline types. The Harbour as a whole has a very high sensitivity to water-borne oil. At the same time, the presence of areas of relatively insensitive sandy beaches in categories 3 and 4 should be noted.

Second, the vulnerability index does not take account of factors which may produce highly local effects. For example, local variations in drainage characteristics, depth of disturbance, and water table behaviour have been observed to affect oil penetration and retention in intertidal sediments (Little *et al.* 1981). Similarly, the effects of oil on *Spartina* marshes can range from complete destruction of the vegetation to apparent growth stimulation, depending on the type of oil and the season and frequency of its application (Baker 1971; Baker *et al.* 1984). The value of predictions of the sensitivity of Poole Harbour shorelines would be greatly enhanced by a knowledge of the behaviour of *local* oil in the range of *local* sediments and marshes. To what extent does the frequent disturbance by bait digging of the gravel beaches and flats of the north shore, for example, affect both their capacity to absorb and retain oil and also their clean-up capability? Is it possible within highly vulnerable areas of intertidal marshland to locate areas of less sensitive vegetation to which, in an emergency, oil might be moved? Indeed, might it not be desirable in such circumstances, perhaps in the winter, when nearby intertidal bird populations are threatened, to use such marshes to 'mop up' water-borne oil? (When oiled in winter, *Spartina* marshes and reed beds may recover by the next spring, exporting much of the oil in the form of detritus (Baker *et al.* 1984).)

Answers to this type of detailed question will clearly form the basis of oil-spill contingency planning, but cannot be provided from a sensitivity assessment based on a shoreline survey alone. Nonetheless, it is equally clear that such an assessment provides the essential general framework, both for answering questions of detail and within which oil-spill contingency plans can be formulated. The proven value and efficacy of the vulnerability index in the absence of experimental evidence (Hayes *et al.* 1981; Baker *et al.* 1984) suggest that is is a helpful and positive first step in such formulations.

In the maps which follow, a four-point scale of ecological sensitivity has been adopted. Shorelines and intertidal areas have been colour-coded from green to red in order of increasing general sensitivity to water-borne oil. Where they are known, local variations within the overall sensitivity grading are referred to in the text accompanying the maps. The procedure has involved first delimiting the least and most sensitive areas (where these clearly correspond to beach types as defined by the Gundlach & Hayes index) and then to interpolate the position of other beaches on the basis of sediment type, invertebrate biomass and bird use. (Where areas carried large populations of bar-tailed godwit or shelduck, for example, they were deemed to be of high sensitivity.)

5.2 Limitations

It is important to note the following limitations to the current sensitivity assessment.

First, it is necessarily limited by the amount and quality of information available to us at present. As well as experimental data of the type referred to in 5.1, more data, eg on the fine-scale distribution of benthic invertebrates and on bird feeding patterns, would undoubtedly increase the resolution of, and even modify, the sensitivity grading of different shorelines. Furthermore, knowledge of the distribution and diversity of sub-tidal organisms within the Harbour and the possible effects of oil on them is needed for any final assessment of relative vulnerability.

Second, the assessment does not fully take account of the interdependence of different parts of the Harbour's ecosystem. For example, a relatively insensitive area may form an integral part of the exploitation of the Harbour by birds which largely feed and roost elsewhere. It is important to consider the extent to which the effects of oil damage in one bay may be transmitted to other areas, both physically and biologically. Again, more data, particularly on projected oil movement, will increase both the precision and reality of the grading exercise.

Third, it should be remembered that such an analysis is essentially a snap-shot of present conditions. Intertidal areas are highly dynamic, as evidenced by the rates of recession of *Spartina* marsh and the concomitant sedimentary and hydrological changes (2). Changes in sensitivity will *ipso facto* follow both these changes in sediment type, as well as other changes such as bird feeding and roosting patterns (known from recent work to have changed in detail from the average picture presented here for 1969-83). The need to keep such an analysis up to date is compelling.

Finally, it should be stressed that the assessment is of *ecological* sensitivity, specifically ignoring questions of land use or valuation. A full environmental sensitivity analysis may need to incorporate such factors. For example, the fine-grained sand beaches at Shell Bay and Studland have a relatively low sensitivity in terms of their biomass levels and vulnerability to long-term oil-spill damage. Yet they are very popular summer bathing beaches. Similarly, water-based recreation along the north shore may alter its general 'sensitivity'.

Despite these limitations, it is hoped that the ecological sensitivity analysis provided here, and, in particular, the set of maps which follow, will form the basis of oil-spill contingency planning into which considerations of the type outlined above can be incorporated. With additional data, the prospect is good for well-formulated and practicable plans for dealing with tide-borne oil in Poole Harbour. The relevance of these plans, and this analysis, is unaffected by the source of oil, be it from oilfield development or, as in January 1961 (Ranwell & Hewett 1964), resulting from a commercial shipping accident.

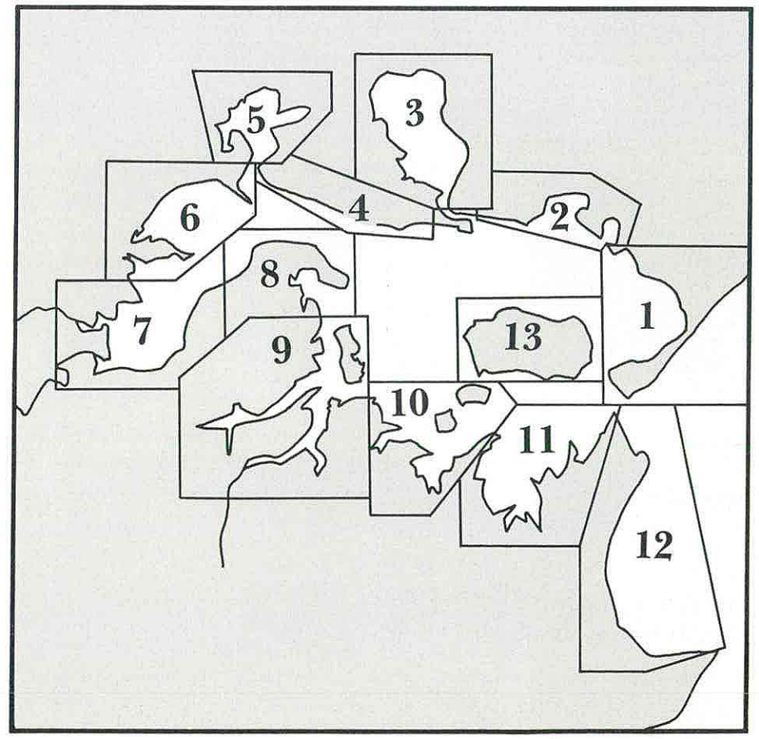
6 SHORELINE MAPS

For the purpose of mapping, Poole Harbour has been divided into 13 conveniently-sized sections (see adjacent map). In the remainder of this report each section is covered by 2 pages of maps and information.

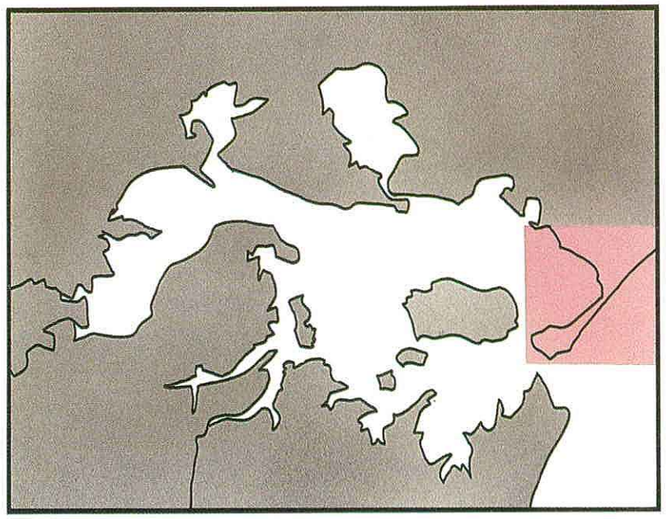
On the first page is a location map, a general description of the area, a map of the relative ecological sensitivity of the shorelines, a map of the major types of land use above the tidal limit, and data on seasonal variation in bird numbers. The bird data have been pooled into 3 main groups, representing 3 groups of species (Intertidal birds, Gulls and Diving birds) which use the harbour in different ways (see 4.1). In each case the *area* of a sector in the pie charts represents the number of all birds of that group which might be found in that section of the harbour in that month (based on data using the highest 10 counts, 1969-83, as outlined in 4.1). This enables overall comparisons to be made between groups, months, and different sections of the harbour.

On the second page is a map of the major sediment and vegetation types, together with an illustrated description of the shoreline in that section.

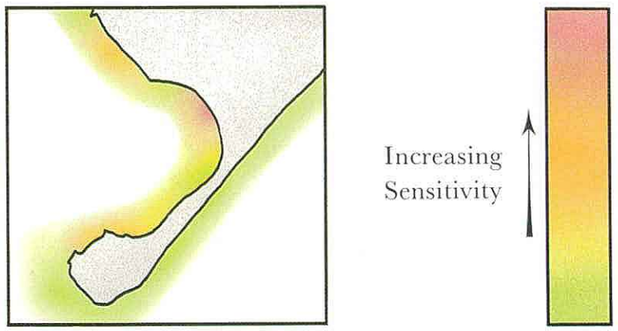
A composite ecological sensitivity map is shown on p.36.



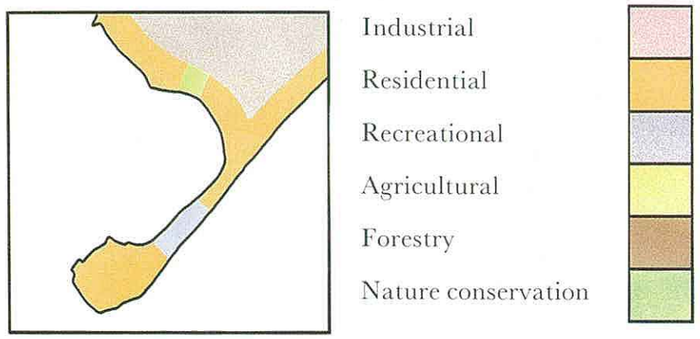
1. Sandbanks



ECOLOGICAL SENSITIVITY



LAND USE

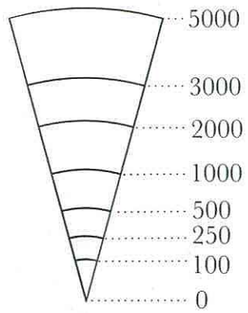


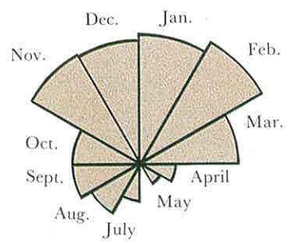
Flanked by two large yacht clubs, the wide sandy bay enclosed by the Sandbanks peninsula is a focus for water-based recreation. The intertidal area is used for mooring pleasure craft, and in recent years the bay has been the favoured area for sailboarding. The nearby holiday beaches on the seaward side of the peninsula and across the ferry at Shell Bay and Studland attract large numbers of summer visitors.

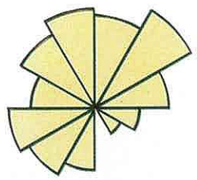
The generally firm sandy substrates are fringed in places at their upper edge by shingle or narrow sand beaches. Boulders, mostly derived from sea walls, are scattered on the upper beach, being particularly frequent along the 2 sections of beach at the mouth of the bay. The small area of saltmarsh is a remnant of more extensive marsh in this area where the sediments have become increasingly sandy. Aerial photographs taken in 1924 reveal a network of meandering intertidal creeks typical of fine mud sediments.

Almost the entire shoreline is protected by concrete or stone embankments. A small area of non-tidal vegetation occurs above the saltmarsh. Although the saltmarsh is relatively small, it contains most of the common intertidal plants found in the Harbour. Similarly, the numbers of intertidal birds are relatively small but most of the commoner species occur. At the same time, easy public access from the road which fringes the bay and the broad views across the Harbour entrance and beyond attract large numbers of people throughout the year. Consequently, this section of shoreline is one where people and wildlife interact to an unusually large degree, a fact which may increase the wider general 'sensitivity' of the area to oil pollution.

BIRDS: SEASONAL VARIATION







INTERTIDAL

The number of intertidal birds, measured as the average numbers of all species, is lower in this section of shoreline than all others except Hamworthy (map 4). Dunlin, which feeds on a relatively wide range of substrate, is the most numerous species. However, Sandbanks, in association with the nearby roost on Brownsea, is the most important area for the small Poole Harbour bar-tailed godwit population, (<200 average), more than half of which may be found here. Up to 20% of the Poole Harbour population of ringed plover and 17% of the turnstone may occur here, but again the absolute numbers are low.

GULLS

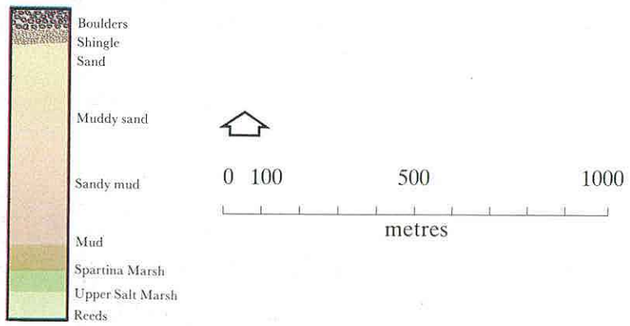
Black-headed gulls, feeding intertidally and roosting at high tide out in the bay, are the most numerous gull species (here and in all areas but Brownsea and Studland Bay) but at Sandbanks rarely exceed 5% of their Poole Harbour total. Although the number of common gulls is low (c. 30) it represents around 25% of the total Harbour population.

DIVING BIRDS

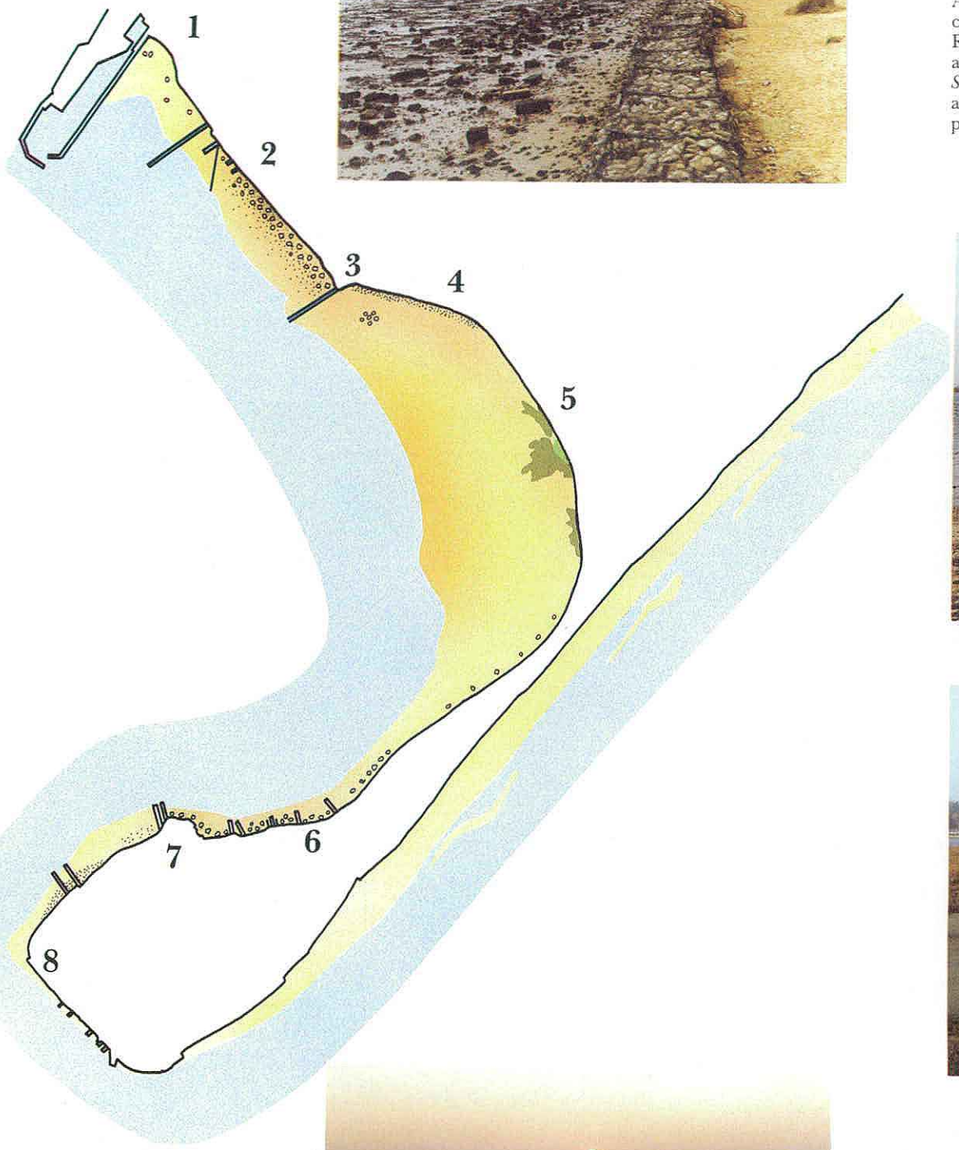
The deep channel seaward of the bay, the area around Brownsea island (map 13) and the Harbour entrance are major feeding areas for diving birds (eg divers, grebes, cormorants). Most severely affected by the 1961 oil spill near the Harbour mouth (Ranwell & Hewett 1964) these species include the red-breasted merganser, the numbers of which counted along this shoreline may reach 20% of the Harbour total, goldeneye (15%) and cormorant (5%).

1. Sandbanks

To the south-east of the Poole Harbour Yacht Club Marina (1) a wide firm sand beach is exposed at low spring tides (above). The upper limit is marked by private gardens, small sea walls, landing stages and slipways. Scattered boulders occur, especially near the Marina.

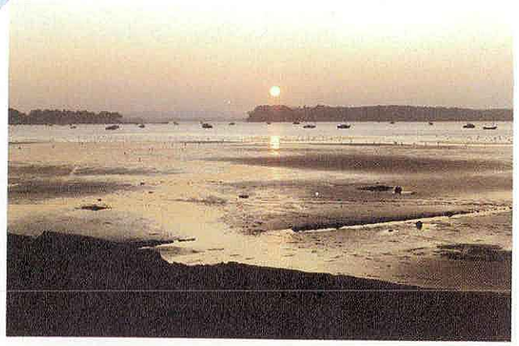


From the Royal Motor Yacht Club (7) westwards to North Haven point (8) a firm sandy beach with shingle patches along its upper edge extends out to the main channel at low spring tides. The length of shoreline running south-east to the chain ferry (above) is faced by stone and concrete walls below private gardens.



South of an outfall pipe (2) and extending below Evening Hill to the East Dorset Sailing Club pier (3), the upper 25m of beach is densely strewn with boulders, many of them large. The concrete walls protecting the private residences are replaced where these end by a line of gabions (rock-filled wire baskets) (left). The beach here is slightly muddier than to the north and is dug for bait (as in other gravel/muddy areas, ragworm – *Nereis virens*).

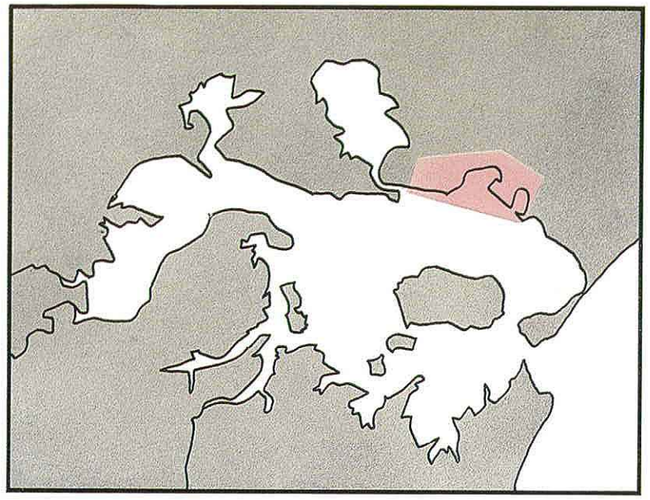
A gravel beach, with widely scattered boulders changes near the Luscombe Valley outfall (4) to sand (below) and further south, below Haven Road, to a fringe of salt marsh (5). The saltmarsh comprises an eroding area of *Spartina* marsh with a mixed marsh including *Aster tripolium* and *Salicornia perennis* above this and along the drift line, *Elymus pycnanthus* and *Leymus arenarius*. The wetter areas at the top of the shore contain patches of *Scripus maritimus* and *Phragmites australis*.



To seaward of these fringing beaches and running down almost to the main shipping channel is a wide expanse of firm intertidal sandflats. These are regularly dug for bait (principally lugworm, *Arenicola marina*) and the presence of shallow water for much of the tidal cycle attracts large numbers of sail-board users. The many hundreds of pleasure craft which may be moored along this shoreline are concentrated in the southern part of the bay (left).

Almost the entire shoreline is protected by a concrete embankment. At its toe, to the south of the marsh, a small shingle beach or scattered boulders occur and west of the jetty where the road joins the shoreline (6) the beach is densely covered with boulders.

2. Parkstone



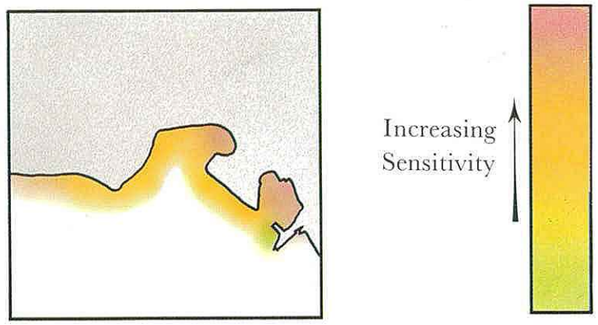
The shoreline from Poole Quay to the Poole Harbour Yacht Club Marina includes the 2 embayments of Parkstone Bay and The Blue Lagoon.

Apart from these bays the intertidal fringe is narrow and exposed for relatively short periods. The intertidal substrates are highly varied from gravels in the east to fine sands and muds in the west. Most beaches are extensively dug for bait and those in the east are used for recreation in the summer. There is a slipway for the public to launch boats at Baiter.

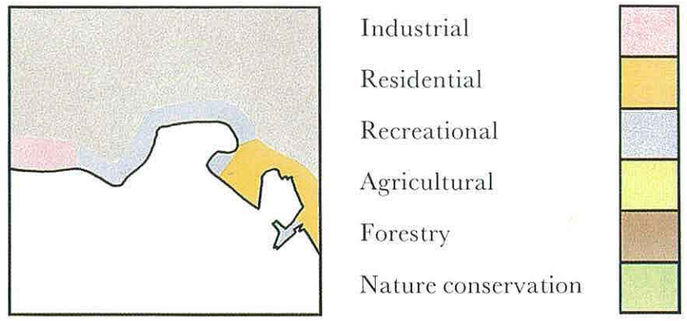
With the exception of parts of Baiter and The Blue Lagoon, the high tide level is marked by artificial embankments. These include loose-rock, stone and concrete-faced walls, metal pilings and gabions.

The grasslands, on reclaimed land, at Baiter and Whitecliffe, form an integral part of this area and are used by intertidal birds for roosting and feeding. Poole Park, with its boating and other lakes, is also a focus for birds, mainly waterfowl.

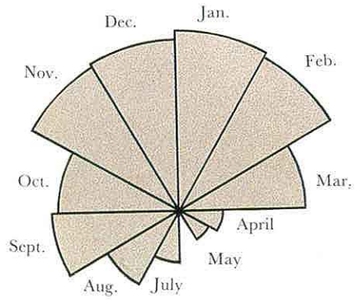
ECOLOGICAL SENSITIVITY



LAND USE

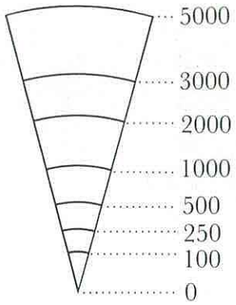


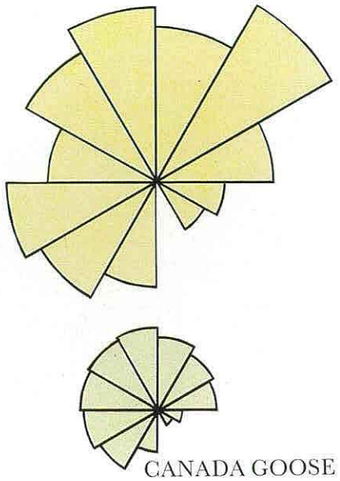
BIRDS: SEASONAL VARIATION



INTERTIDAL

The most numerous intertidal bird species are dunlin and mallard. Dunlin, and other intertidal feeders, are able to feed in the upper, north-eastern, part of Parkstone Bay which is uncovered at neap tides, and exposed for over 6 hours on Spring tides (Goss-Custard & Durell 1984). Mallard are attracted to the freshwater areas at Poole Park. Although less numerous, ringed plover, which generally prefer to feed on sandier substrates, and turnstone, a gravel beach feeder, may occur in numbers which exceed 60% and 40% respectively of their Poole Harbour total. The numbers of oystercatchers, feeding in the fields at high tide and in wet weather, may also reach nearly 50% of the Poole Harbour population.





CANADA GOOSE

GULLS

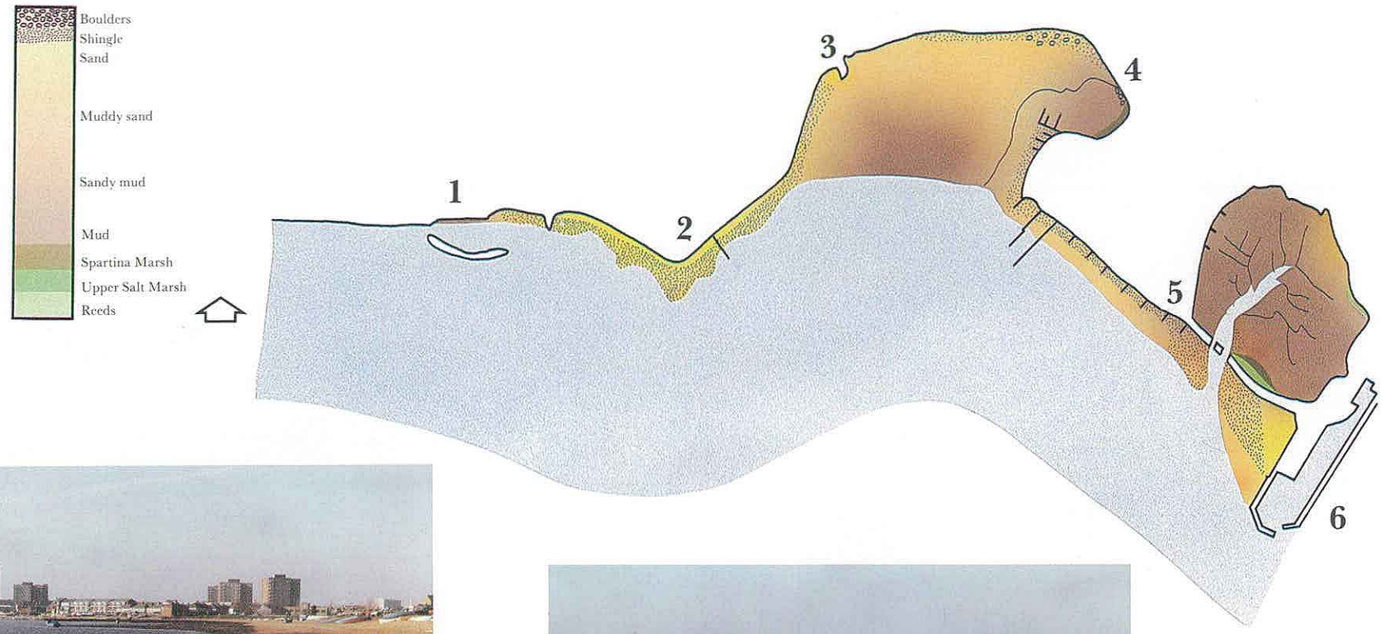
Black-headed gulls, also feeding in the fields and intertidally, occur in large numbers, particularly in February. They are attracted to Poole Park and will roost on the Boating Lake. Although the numbers are much smaller (> 1500 black-headed gulls compared to < 50 common gulls) this area is the most important in the Harbour for common gulls.

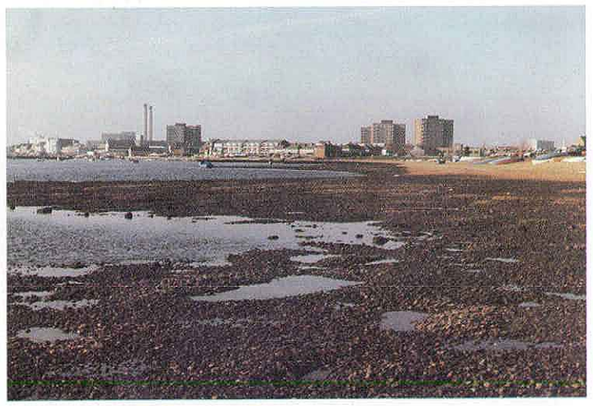
Also attracted to the Park are tufted ducks (at c.420 up to 75% of the Harbour population), coot (270) and mute swan (75) – the last 2 in numbers which exceed 80% of their Harbour populations. The Canada goose was introduced to Poole Park by wildfowlers in 1956, and this area contains numbers approaching 400 in the winter months – more than 90% of the Harbour total.

2. Parkstone

Outside Parkstone Bay and The Blue Lagoon the relatively narrow intertidal fringe along this section of shoreline consists mainly of poorly-sorted sediments dominated by gravels. At the Fisherman's Dock (1) soft muddy sediments below a narrow shingle beach are replaced to the east by a flat, firm, but much disturbed zone of gravel in a matrix of muddy sands. Extending around the point at Baiter and beyond the public slipway, the gravel flats are backed by a narrow sandy beach and low earth cliff.

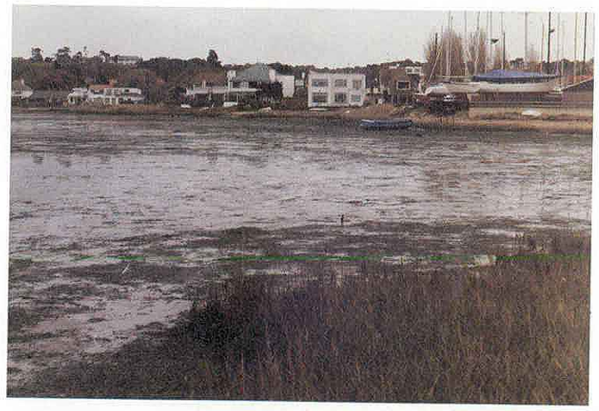
Within Parkstone Bay (left) the intertidal flats are firm and sandy but become both muddier and softer towards the low tide mark and into the eastern corner (especially east of a small creek draining the recreation ground (4)). The upper beach is strewn with large boulders, particularly in front of the loose rock embankment from the Boating Lake outfall (3) to Whitecliff. The small area of upper beach and marsh in the eastern corner, bounded to the north by a smooth stone sea wall and to the south by metal pilings, appears to receive most of the Bay's tide-borne debris.





The extensive gravel beach at Baiter exposed on a low Spring tide viewed from its southern tip (2) westwards towards Poole Quay (above) and north-eastwards into Parkstone Bay (right).

Between the Parkstone and Poole Harbour Yacht Club, and including the perimeter of The Blue Lagoon, the shoreline largely marks the edge of private residences. West of the lagoon entrance (5) these are protected by concrete and stone walls at the foot of which is a narrow sandy beach, strewn in places with shingle and crossed by several breakwaters (above). Within The Blue Lagoon private gardens slope gradually down to extremely soft, muddy sediments (below). The firm gravel banks near the entrance and recently reinforced sea wall are clearly used as access points for bait diggers to venture on to the softer areas. Fringing the lagoon are small areas of *Spartina* marsh and higher marsh dominated by *Halimione portulacoides*.

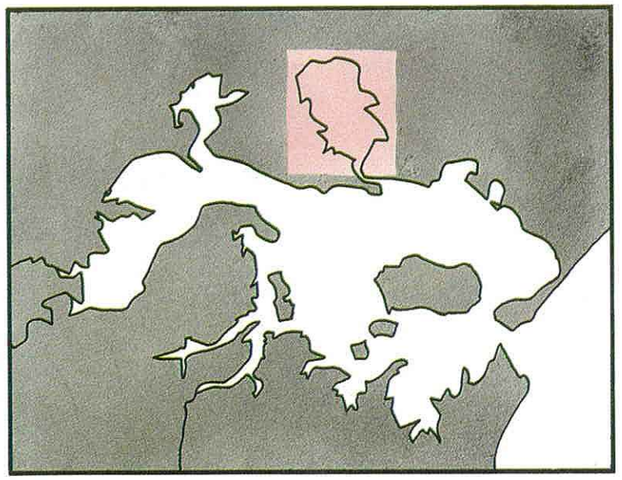


In the angle between the shingle-topped bank at the entrance to the lagoon and the western wall of PHYC Marina (6) is a narrow sandy beach, below which, exposed at low water springs, is a firm flat beach of well-sorted very fine sand, similar in type to that east of the Marina (see Map 1).

0 100 500 1000

metres

3. Holes Bay



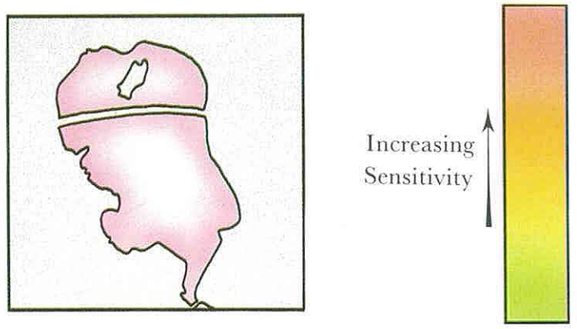
Holes Bay is an almost enclosed muddy northern arm of the Harbour, much affected over the years by land reclamation and the spread and subsequent decline of *Spartina anglica* salt marsh. Since 1924 the intertidal area has been reduced from c. 330 to less than 250 ha, mainly by reclamation along the east shore for port and urban development, the most recent being that started at Sterte in 1983. At the same time the area of *Spartina* marsh has declined from more than 200 to around 70 ha – the proportion of the intertidal area it occupies reducing from 63% to 29% (Gray & Pearson 1983, 1984). This decline began before the widely observed increase in green algal growth on the mudflats. Nevertheless, the poor flushing characteristics, combined with discharges from sewage treatment works at Creekmoor, and industrial effluents, mainly along the east shore, have given rise to concern about the levels of pollution in the Bay (Anon 1981).

The Bay is lined by artificial sea walls, boulder embankments and quays, but transitions to low flood banks and to natural rises in the land occur in the north-west corner, in isolated areas along the west shore, and around Pergin's Island. The substrates between the highly fragmented *Spartina* marshes are very soft mobile muds (which, in many areas, are extremely dangerous to attempt to cross), but small local boulder and gravel beaches occur, usually associated with embankments.

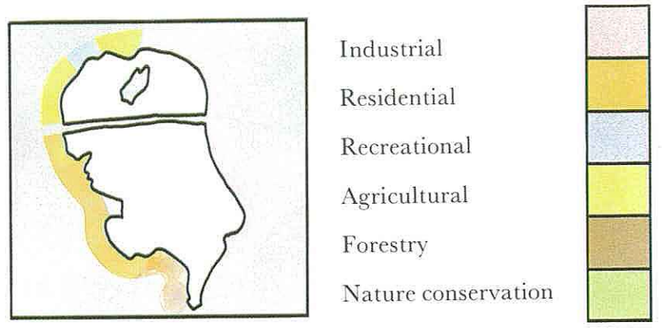
Despite the muddy substrates, the shelter of the Bay and safe moorings it provides attract a large number of boat owners. Small craft abound in all the creeks and marshes along the west shore and Cobbs Quay is a focus for boat-building and a marina for larger private pleasure craft.

Although the invertebrate fauna is relatively impoverished, consisting mainly of polychaete worms, the mudflats, creeks and marshes, together with surrounding agricultural and reclaimed land, support large numbers of intertidal birds. Redshank, and dunlin are especially numerous; a relatively high proportion of the Harbour total of curlew and black-tailed godwit and shelduck, teal and pintail regularly occur. The diversity of bird species is also high, with Holes Bay containing relatively high numbers of several gull species, of diving birds such as goldeneye, and of water's edge birds such as heron and moorhen.

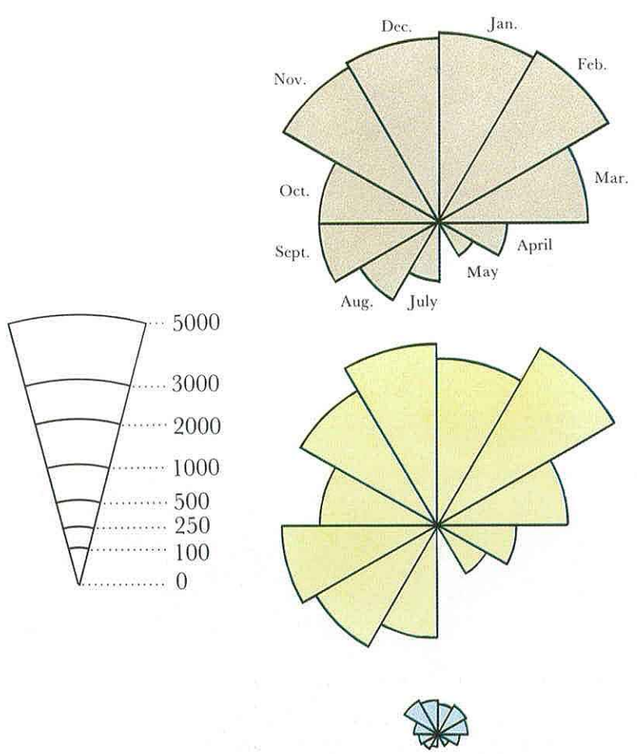
ECOLOGICAL SENSITIVITY



LAND USE



BIRDS: SEASONAL VARIATION



INTERTIDAL

The Bay is a particularly important area for redshank (c. 480) and dunlin (c. 1080), holding at times a third and a quarter respectively of their Poole Harbour totals. A recent study by Goss-Custard and Durell (1983) confirms that the main feeding areas for these species are in the northern part of the Bay. Redshank are particularly numerous to the east of the central tongue of *Spartina* marsh between Upton and Creekmoor lakes south of the railway, whereas dunlin occur mainly on the mudflats north of the railway, especially around Pergin's Island. Also feeding in the north, where the mudflats uncover early (c. 1½ hrs before low water) and around the central *Spartina* are shelduck and curlew, the latter also feeding in nearby fields. The numbers of shelduck and redshank are high in August but the great rise in numbers of intertidal feeding birds in November is because of the influx of dunlin. Black-tailed godwit may occur (up to 15% of the Harbour population), and, of the waterfowl, pintail (130 : 33%) and teal (250 : 17%) are especially numerous.

GULLS

The Bay and its environs attract a high proportion of Poole Harbour's gull populations. Common gull (40), greater black-backed gull (20), herring gull (390), and the ubiquitous black-headed gull (1700) all occur at levels in excess of 30% of their Poole Harbour totals. Goss-Custard & Durell (1983) observed this last species feeding intertidally and in nearby fields, and all gull species are attracted to the nutrient-rich areas of mud north of the railway and the adjacent reclaimed land.

DIVING BIRDS

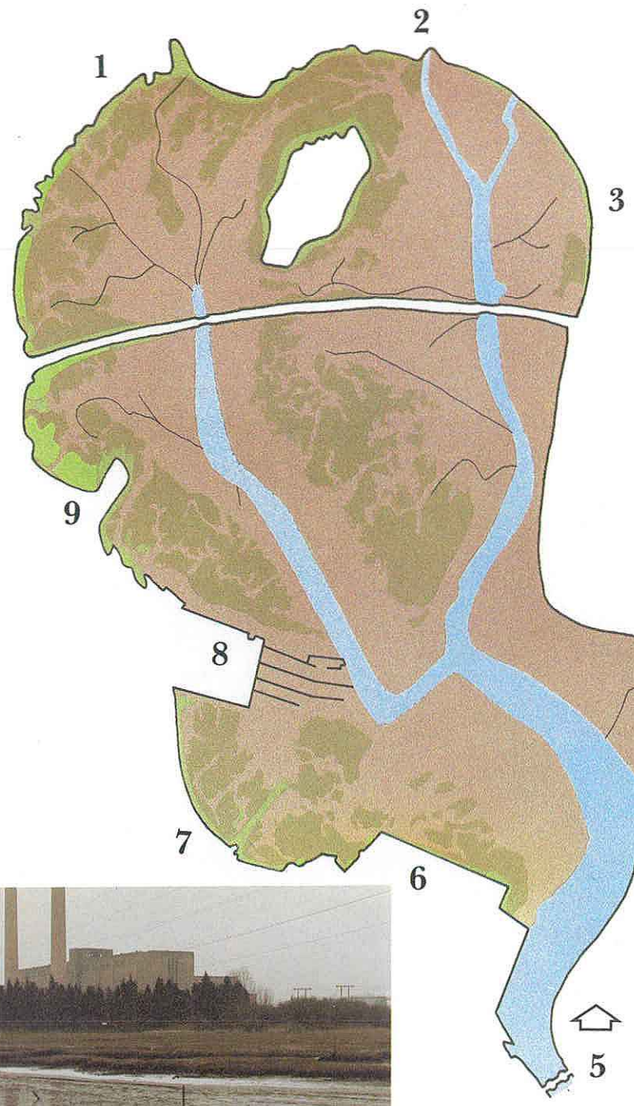
Of the diving birds which penetrate into the Bay, goldeneye, also numerous at nearby Parkstone, may reach almost 20% of their Poole Harbour total. Together with cormorant, their numbers generally reach a peak in November.

The numbers of heron, moorhen and mute swan in the Bay, although small, represent more than 50%, 40% and 30% respectively of the Harbour total.

3. Holes Bay

North of the railway viaduct, the upper shore may be divided into 2 sections: westwards from the outfall at Creekmoor (2) the *Spartina* marshes, including those around Pergin's Island, are backed by transitions through brackish marsh to semi-natural grasslands or farmland. Communities dominated by *Juncus maritimus, Elymus pycnanthus* and *Phragmites australis* are common above the *Spartina* marsh and can be seen below left in the vicinity of Upton Country Park (1). Eastwards from the Creekmoor outfall the high tide level is marked by a limestone embankment (below right taken at 3) with a small area of *Spartina* marsh remaining north of the railway.

Apart from small local boulder beaches, the intertidal area seaward of the marshes and banks comprises very soft mobile muds across which it is extremely difficult, and indeed dangerous, to walk.



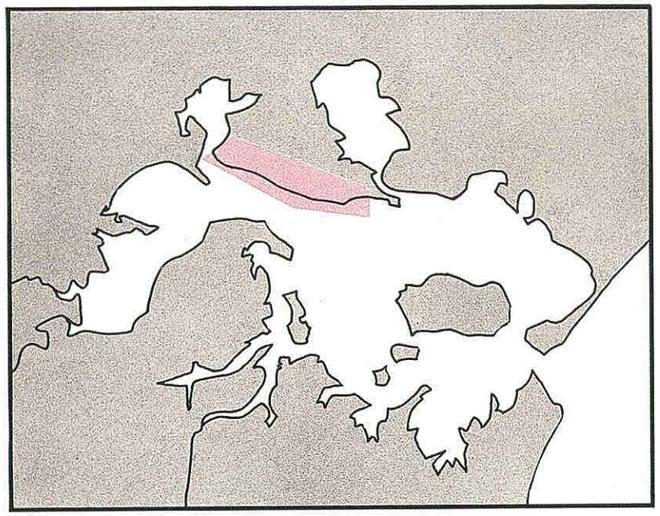
The east shore south of the railway consists entirely of artificial embankments at the seaward edge of reclaimed land. These include the limestone boulder banks fronting the 1983 reclamation from the railway to Poole Station and the various pilings, wharves and jetties which make up the dockland frontage of West Quay down to Poole Bridge (5). The area of very soft mudflats to seaward includes some *Spartina* marsh, notably below Sterte (4, and photographs below).

Boulders
Shingle
Sand
Muddy sand
Sandy mud
Mud
Spartina Marsh
Upper Salt Marsh
Reeds

0 100 500 1000
metres

Along the west shore highly fragmented *Spartina* marshes, intersected by soft muddy creeks, are backed to landward by the banks of land reclamations, such as that for the Hamworthy Power Station (6) and at Cobbs Quay boatyard (8). Transitions to other plant communities occur, notably in the bay and around the promontory immediately south of the railway (9) – an area of recent residential development. The marshes below Cobbs Quay are also backed by private residences (above, centre), and a school. Their main features can be seen in the photographs immediately above, taken from the tip of the promontory (at 7), looking north to Cobbs Quay (left) and south-east to the Power Station (right).

4. Hamworthy



The shoreline from Rockley Point westwards to the new yacht marina at Lower Hamworthy comprises a relatively narrow strip of mainly sand and gravel beaches. Although narrow, the beaches are popular summer recreational areas with Rockley Sands holiday camp, a large caravan and chalet complex, in the west and a public open space at Hamworthy Park in the east. Angling is a popular winter activity here and ragworm is dug for bait along most of the shoreline in poorly-sorted gravel substrates similar to those at Baiter (map 2).

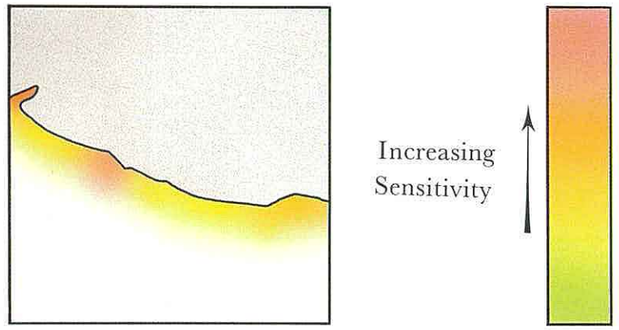
Slipways, piers and boatyards are concentrated in the central area around Lakeside from where the Royal Marines Amphibious Training Unit use the Harbour for training purposes. To the east there are several slipways, from which small craft can be launched.

Small areas of muddier sediments occur in a bay south of the railway at Rockley Point and east of the boatbuilding yards at Lakeside. In other places the gravel beaches below mid-tide level may be in a matrix of either sandy muds or very fine sands.

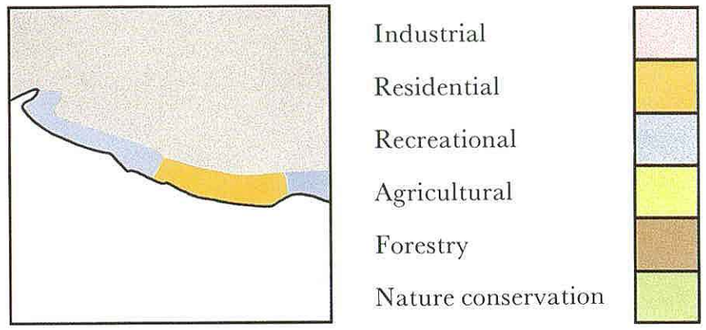
From Rockley Point to Lakeside the beach is flanked by a high, natural cliff of Bagshot deposits, the toe of which, at the eastern edge, marks the high tide level, (and is currently protected from erosion). From Lakeside eastwards, private residences and the recreation ground at Hamworthy are protected by stone, brick, and concrete sea walls, and the new marina wall is of limestone boulders.

Although the gravels are rich in polychaete worms they are not extensively exploited by intertidally-feeding birds, at least in the eastern section of this shore.

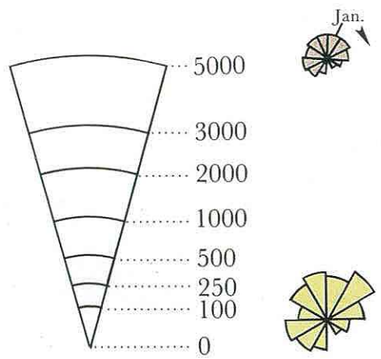
ECOLOGICAL SENSITIVITY



LAND USE



BIRDS: SEASONAL VARIATION



INTERTIDAL

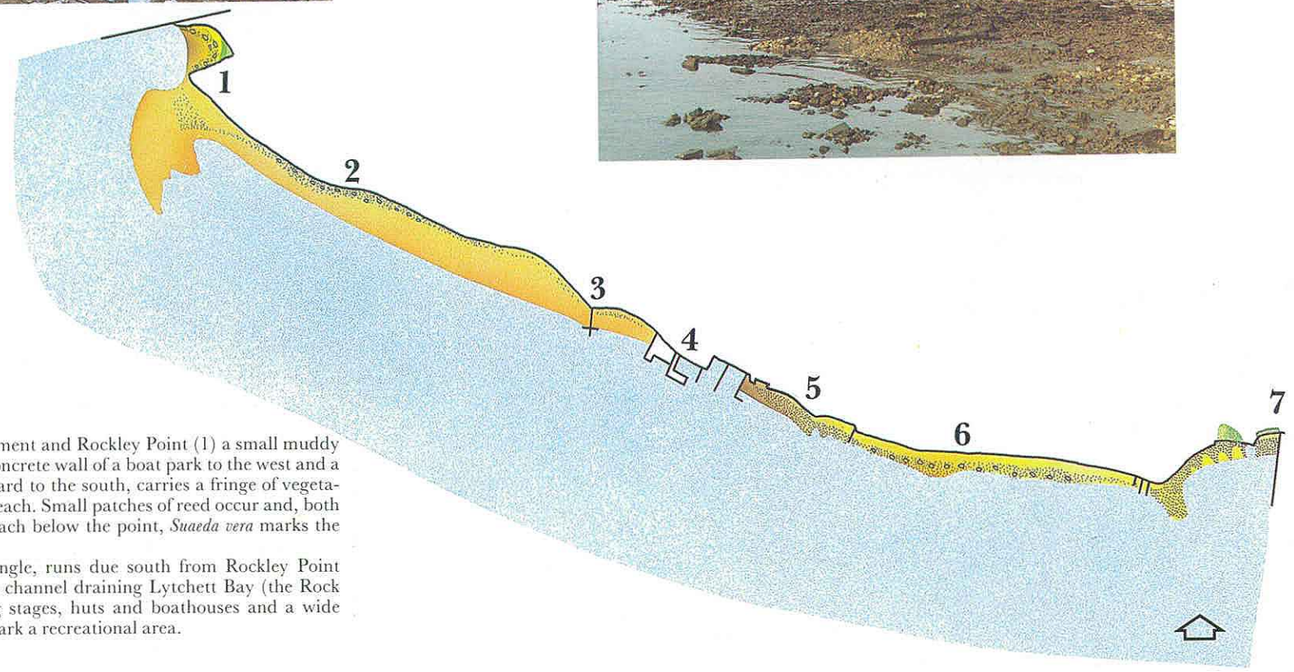
Because of the way in which the areas for counting birds in the Harbour were divided, it is not possible to provide data for the whole length of this shoreline. Birds observed west of the pier (at 3 on the map below) would not be included in the north shore data. However, it seems from the counts made in the eastern section that this area is not extensively used by birds. The only notable intertidal species is ringed plover, occurring at up to 9% of their Poole Harbour population. Oystercatcher, turnstone, redshank and dunlin have also been regularly recorded, but in rather small numbers – suggesting that the polychaete worms present in high densities in the 1970s survey (from 500 to more than 5000 per metre^2) are not readily available, or available for insufficient time.

GULLS

Gulls, of which the black-headed gull is the most numerous (c. 100) also occur in small numbers along the eastern part of this shoreline.

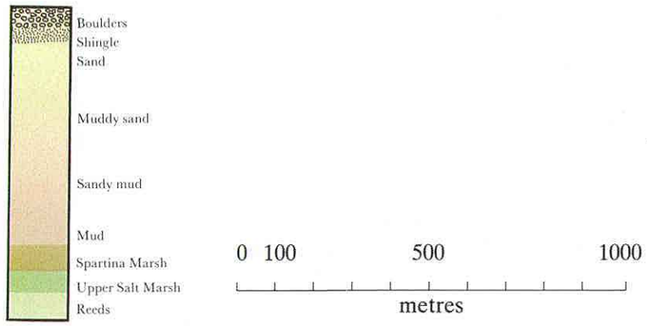
4. Hamworthy

The sand beach below the Rockley Holiday camp at first narrows (2, below) and then widens near the pier and car park (3, right). To seaward the type of substrate exposed at Spring tides varies from muddy sands with boulders and gravel beaches to, near the pier, firm wave-rippled sandflats with scattered shingle. To landward a natural cliff of Bagshot sands and gravels, between 5 and 10 m high, runs down to Lakeside (4). The toe is protected along the narrow zone (2) by concrete or wire netting but further east a natural transition cliff to heathland vegetation occurs.

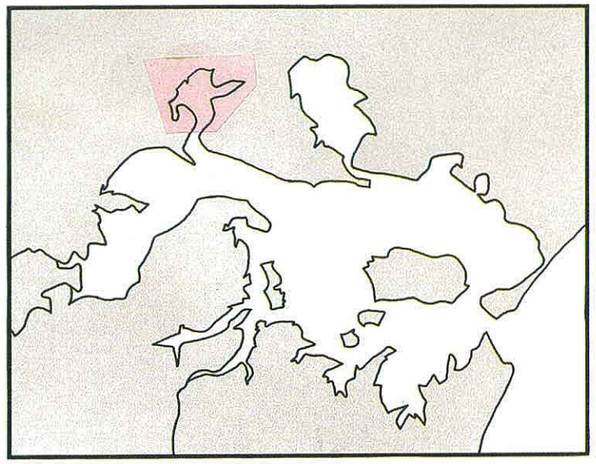


From Lakeside (above) to the boulder embankment of the new marina (7) a gravel beach is exposed at low Spring tides. In a matrix of mud west of the public slipway (5) the gravel is fringed to landward by a gently shelving sandy beach, covered in places by shingle. Backed by concrete walls at the foot of private gardens and crossed by several breakwaters, pipes, and slipways, this beach varies considerably in width. Where it widens below Hamworthy Park (6) it is a locally popular public bathing beach lined by a concrete wall topped with beach huts (below). At the western edge of the recreation ground a cusp-shaped gravel beach extends to the power station outfall, surrounding which is a small fringe of vegetation.

Between the railway embankment and Rockley Point (1) a small muddy embayment, backed by the concrete wall of a boat park to the west and a boulder bank and concrete hard to the south, carries a fringe of vegetation above a narrow, sandy beach. Small patches of reed occur and, both here and at the top of the beach below the point, *Suaeda vera* marks the extreme high tide level.
A sandspit, fringed with shingle, runs due south from Rockley Point along the eastern edge of the channel draining Lytchett Bay (the Rock Lea river). Concrete landing stages, huts and boathouses and a wide sandy beach above the spit mark a recreational area.



5. Lytchett Bay



Smaller than Holes Bay to the east, Lytchett Bay is considerably less modified by reclamation, and has generally less muddy and nutrient-enriched sediments. The 2 sides of Lytchett Bay present a contrast in shoreline types. The west shore, which receives the outfall of the Sherford river in its centre, is lined by a series of low earth embankments with extensive reedbeds and woodland in the south and reclaimed pasture in the north. Access to the *Spartina* marshes and soft mudflats of the intertidal area through almost impenetrable carr and reeds is difficult and the hinterland is privately owned.

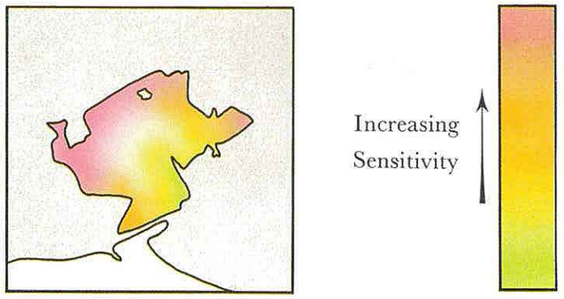
In contrast, the eastern shore, with Upton to the north and the new housing estate of Turlin Moor to the south, is more frequently visited and from the playing fields southwards there is easy public access to a more open and sandier shoreline.

Along the north east edge, private residences south of Sandy Lane, Upton, have only partly obscured the transition from brackish saltmarsh to wet heathland and mixtures of plant species from both biotopes occur. The seaward edge of these marshes and the east shoreline down to the Rockley Viaduct are dominated by erosional features. Saltmarsh cliffs, sand and gravel beaches, buried *Spartina* marshes, and large amounts of driftline material all indicate the effects of wave action – presumably, in this enclosed embayment, generated by the prevailing winds at high tide across the fetch from the south west.

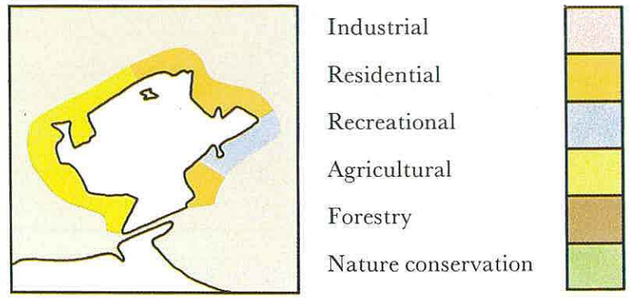
Small craft are moored along the eastern shore (including several Poole canoes, a traditional local type of boat – one, named Jess, can be seen in the bottom left of the map page). The intertidal flats, here principally sandy muds and muds, are firmer than on the west shore.

The most numerous bird species is the black-headed gull, the average high count of more than 2000 individuals representing around 45% of the Poole Harbour population. Long-billed waders such as redshank and curlew are well represented (although less numerous than the ubiquitous dunlin) as are other freshwater marsh and field-feeders, eg common snipe and lapwing.

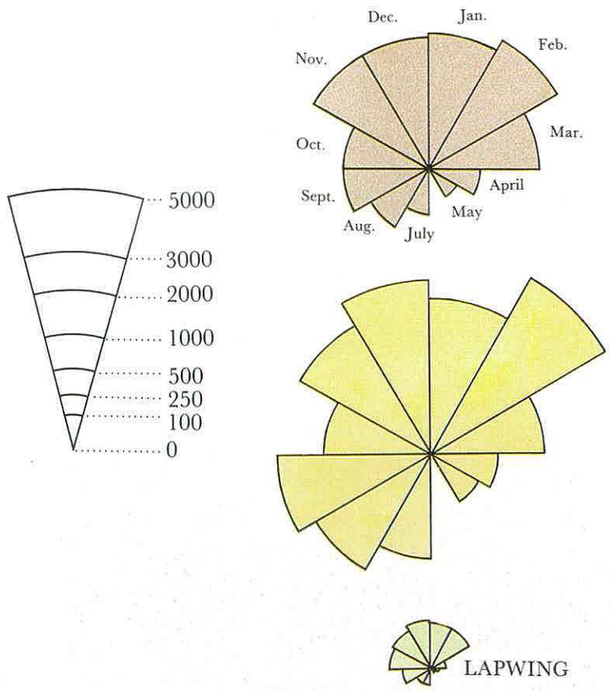
ECOLOGICAL SENSITIVITY



LAND USE



BIRDS: SEASONAL VARIATION



INTERTIDAL

None of the intertidally-feeding wader and wildfowl species have been regularly recorded in exceptionally large numbers. Dunlin is the most numerous, the 720 average representing around 6% of the Poole Harbour total, but redshank (270) and curlew (125) are proportionally the most important species, their numbers representing 19% and 12% of their respective Harbour totals. Small numbers of other long-billed waders, oystercatcher, black-tailed godwit and greenshank, occur

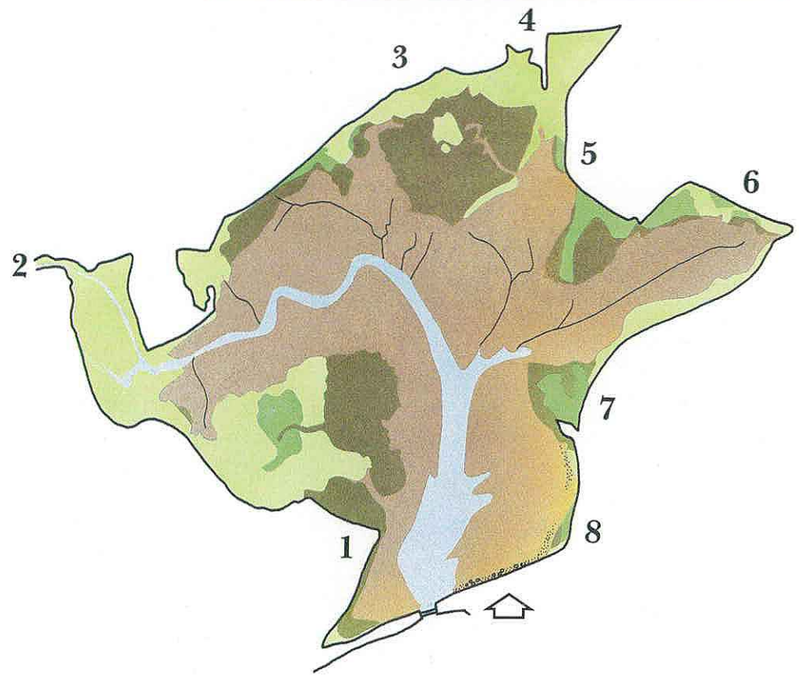
GULLS

The high numbers of black-headed gulls (the average high over the 10-year period being in excess of 2000 or 45% of the Harbour population) is presumably related to the presence of nearby urban and agricultural land. The Bay was not being used as a night-time roost when observations were made in November 1984. Breeding colonies (c. 200-400 pairs) occur on the Holton Heath foreshore and Wood Bar to the south (map 6) (Prendergast & Boys 1983).

Common snipe, lapwing, heron, kingfisher, coot, and mute swan are regularly seen, reflecting the freshwater marshes and margins.

5. Lytchett Bay

From Holton Point in the south west (1) around to a point south of Upton (5) the upper shoreline of the Bay is largely fringed with reedbed. To landward lies woodland (at Holton Heath and around Otter Island) and extensive low-lying marshy ground (around the Sherford river (2) and along the north-western edge, where it has been drained and is grazed). The reeds are invaded by willow, birch and gorse with patches of bracken on higher ground (near right, taken at 3). In some areas, for example south of the sewage works (4), brackish marsh species such as *Juncus maritimus* and *Scirpus maritimus* are found intermixed with acid wetland species such as *Molinia caerulea* and *Myrica gale*.
To seaward of the reeds in the west lie areas of soft mud and, east of Otter Island and along the north-west shore, *Spartina*-dominated salt-marsh. From Upton southwards along the east shore, the lower edges of the marshes show erosional features with low cliffs and small beaches of sand and gravel (far right, at 5).

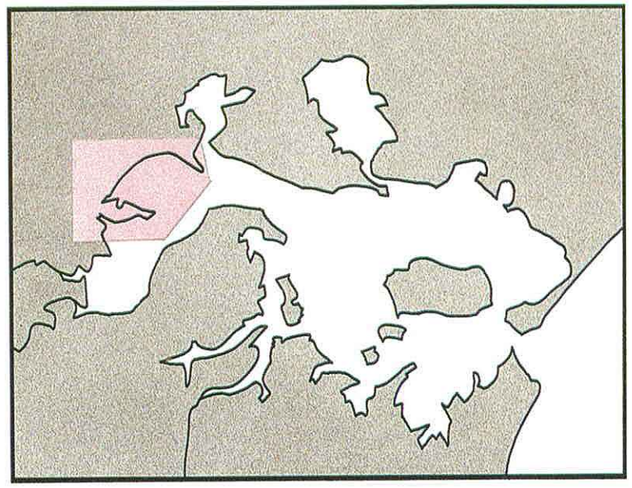


0 100 500 1000
metres

Boulders
Shingle
Sand
Muddy sand
Sandy mud
Mud
Spartina Marsh
Upper Salt Marsh
Reeds

The inlet on the east shore, backed by private gardens to the north and a recreation ground to the south, is lined with reeds and willow carr. The curious mixture of saltmarsh and acid wetland species observed elsewhere in the Bay is evident here (above centre, taken at 6). The reeds fronting the waste ground along the playing fields are replaced to the west of the Turlin Moor housing estate (7) by a species-rich saltmarsh with *Puccinellia maritima* and *Halimione portulacoides* as major components. The *Spartina* marsh to seaward (above) has an eroded lower edge, as have the patches of vegetation to the south below the grassland west of Turlin Moor, and the earth cliff and boulders of the Rockley Viaduct. Here gravel or sandy beaches with isolated clumps of *Phragmites* or *Spartina* slope down to firm sandy muds or muds (left, at 8 looking south-west to the railway and west to Holton Point.)

6. Keysworth



This section of shoreline includes the tidal and reclaimed marshes north of Keysworth Point, the tongue of salt marsh known as Keysworth Marsh, and the muddy embayment of Holton Mere, the northern edge of which is marked by the outfall channel from Lytchett Bay. Except in the north, the intertidal sediments are largely well sorted silts and clays (median particle size <63 μm), producing soft, mobile mudflats in those areas not colonised by vegetation. The main vegetation types are *Spartina*-dominated marsh and reedbed, but in places other species have invaded the former *Spartina* marsh to produce a mixed upper marsh community.

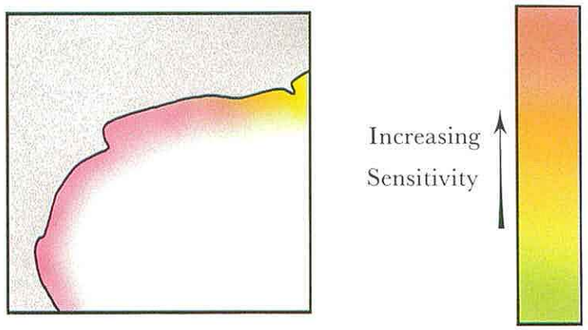
Keysworth Marsh, the landward edge of which is grazed by cattle, is the largest continuous area of salt marsh in the Harbour (c. 45 ha). It developed rapidly in the early part of this century and stratigraphical studies in the 1960s indicated that, in places, more than 180 cm of sediment had been trapped since the initial establishment of *Spartina* (Hubbard & Stebbings 1968). The development of Keysworth Marsh is believed to have hastened the disappearance, by 1924, of Holton Mere or Lake, a shallow irregular-shaped lagoon to the north of the Wareham channel. The invasion of the *Spartina* marsh, noted in the 1960s, continues, particularly by *Puccinellia maritima* at the landward fringe, by *Phragmites australis* along the southern edge, and by *Elymus pycnanthus* and *Halimione portulacoides* on the levees of creeks draining the marsh to the north.

The southern edge of Keysworth Marsh is marked by an eroding cliff but accretion is apparently continuing along most of the northern edge, and in front of the marshes northwards to Holton Heath. The lower levels of the marshes west of Holton Heath, including the spit of marsh at Rockley and the bays near the former jetty, show erosional features and, together with the islands of marsh at Holton, have been reduced in area since the 1950s.

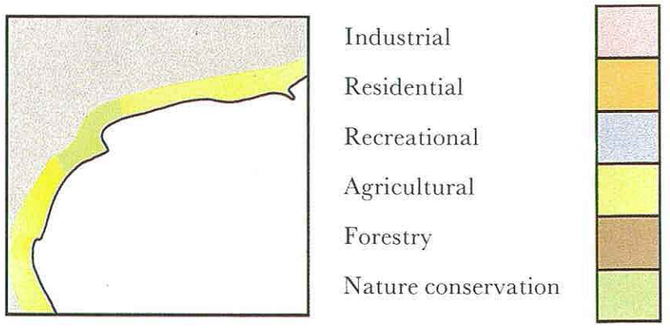
The reclaimed pastures in the south and woodlands in the north are separated from the intertidal areas by small earth embankments but transitions from reedbed to willow and alder carr occur between Keysworth Marsh and the railway embankment.

The encircling railway, private ownership, and difficult terrain, effectively reduce public access to this shoreline. The consequent lack of disturbance, combined with the reclaimed marsh and wetlands to the south (and Lytchett Bay to the north) are likely to be important factors contributing to the presence of large populations of several wader and wildfowl species.

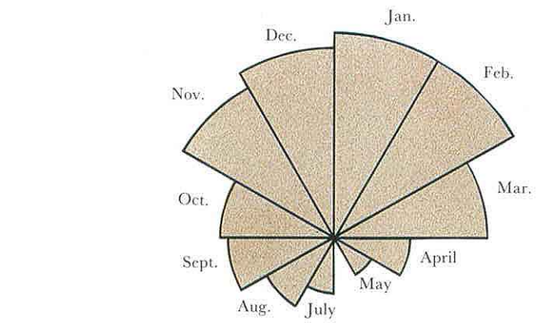
ECOLOGICAL SENSITIVITY

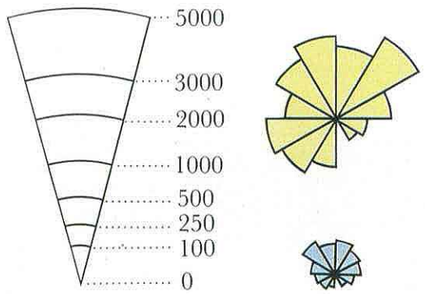


LAND USE



BIRDS: SEASONAL VARIATION





INTERTIDAL

Among the intertidal waders, dunlin (> 900) and redshank (c. 300) may be found in this section in numbers which exceed 20% of their total Poole Harbour populations. Both species will feed at the tide edge and on the mudflats, along salt marsh creeks and in the nearby reclaimed marshes and fields. The presence of these relatively undisturbed grazing marshes is reflected in the numbers of other waders which may feed and roost there – around 10% of the Poole Harbour populations of curlew, grey plover and oystercatcher may occur as may up to 14% of the black-tailed godwit population. The large numbers of wigeon and shelduck, both around 20% of the Harbour population, also reflect the lack of disturbance. The former are grazers of aquatic plants, especially *Enteromorpha*, whereas the latter feed mainly on *Hydrobia*, a small snail which occurs in large numbers in these muddier areas (and is also a main prey of the dunlin). Creeks in the marshes and reclaimed land attract also teal (at times >10% of Harbour total).

GULLS

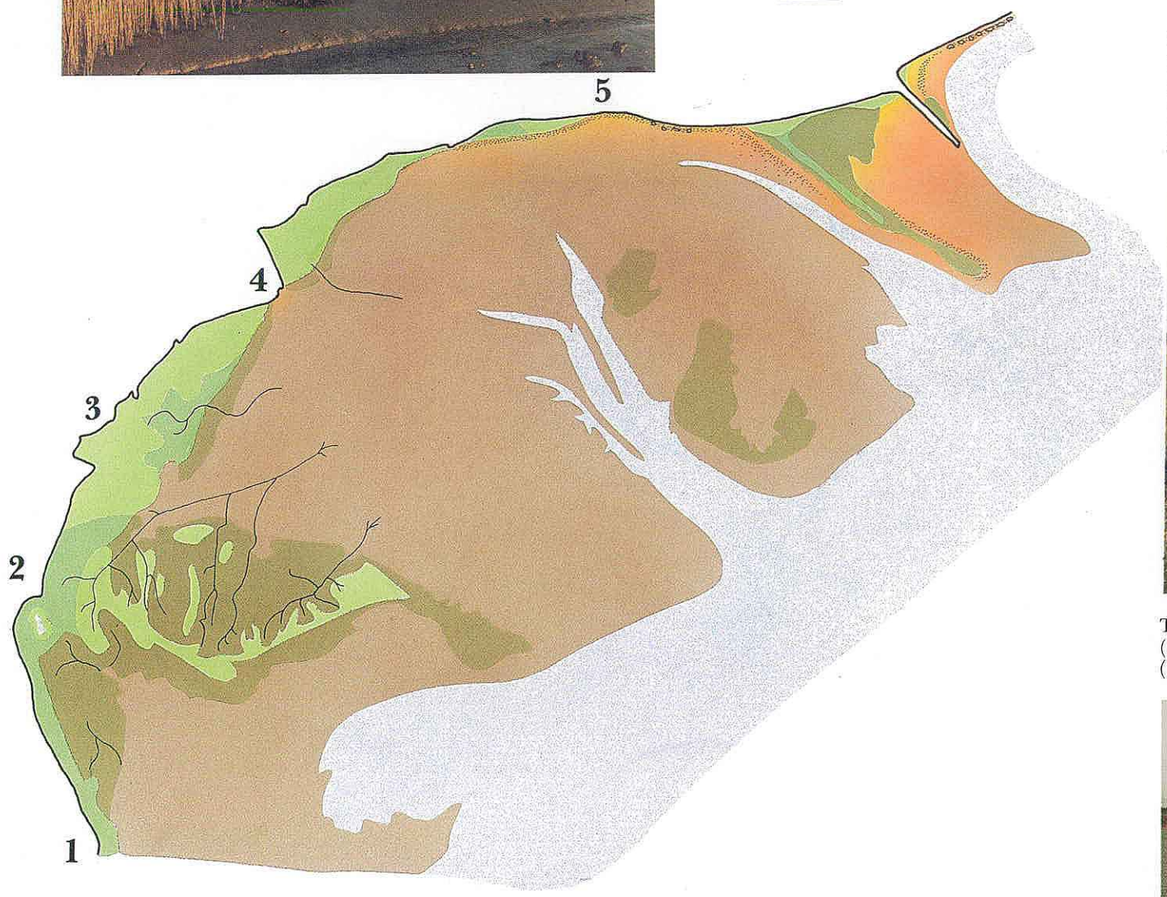
Relatively small numbers of gulls occur. For example, less than 400 black-headed gulls are regularly counted compared with more than 2000 in Lytchett Bay to the north and almost 1000 in the area to the south.

DIVING BIRDS

A small number of diving birds occur in this upper part of the Harbour, populations of the main species, cormorant and red-breasted merganser, being highest in November; goldeneye and scaup occur in small but significant numbers, and all 4 species exceed 10% of their Poole Harbour totals.

6. Keysworth

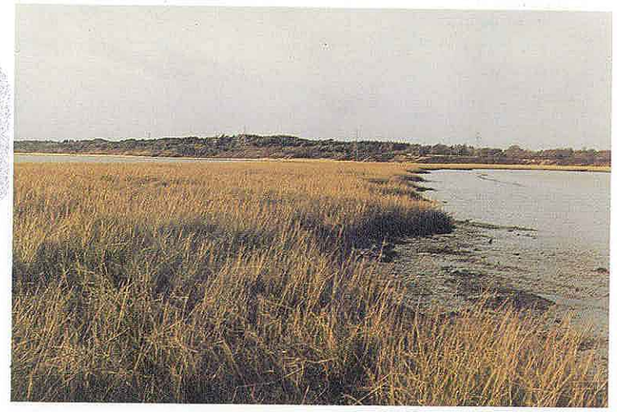
0 100 500 1000
metres



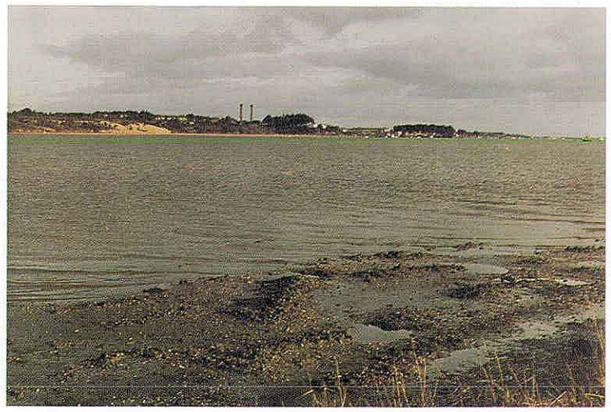
North of Keysworth Point (1) a low earth embankment separates the *Spartina* marsh, invaded by *Puccinellia maritima* and other species at its upper edge, from the reclaimed pasture to the west. From the seaward edge of the marsh (left, lower photograph) soft mudflats extend down to the low tide level. The Keysworth Marsh (2) is also fringed by soft muddy substrates – below a small cliff along its southern edge and level with apparently advancing *Spartina* to the north. A small shell beach may be found at the tip of this marsh.

From Keysworth Marsh where it is occasionally cut for thatching, an almost continuous fringe of dense reedbed (middle left) extends northeastwards. Its landward limit is marked by woodland; with birch, willow and alder invading the upper edge. In the south (3) and below the railway embankment the reeds extend down to the intertidal mudflats but *Spartina*-dominated marsh lies to seaward along most of their edge (upper left and above, photographed at 4).

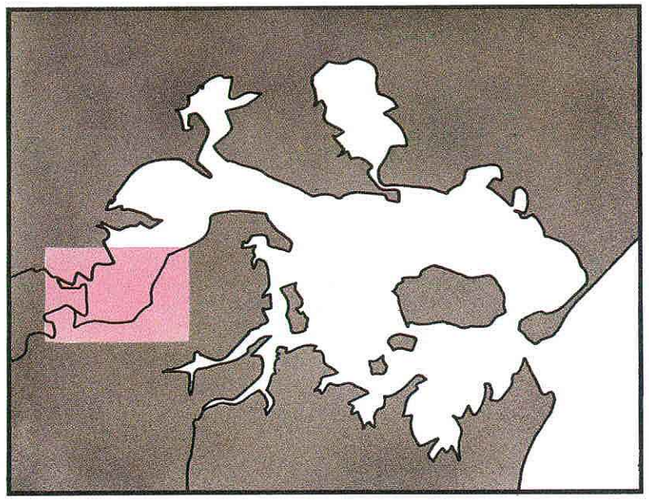
South of the railway embankment the fringe of marsh at first has an erosion cliff at its lower edge (5, and above) and is then replaced by a shingle and boulder beach west of the spit of *Spartina* marsh at Rockley. This marsh, much invaded by *Elymus pycnanthus* and other species, has eroded edges marked by mud cliffs to the south and sandy muds with shells and shingle to the north.



The tip of Rockley Marsh spit looking landwards to Holton Heath (above) and eastwards across the Wareham Channel to Lakeside (below).



7. Upper Wareham Channel



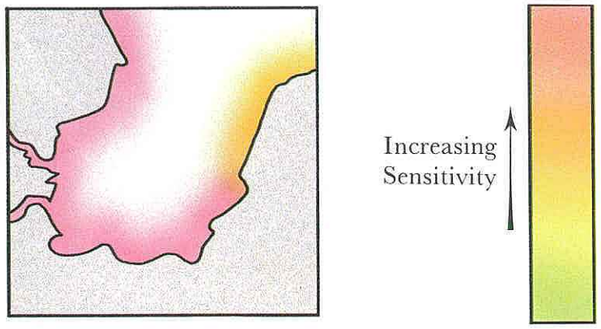
The upper estuary, where the rivers Piddle and Frome enter and unite to form the Wareham Channel, is flanked by extensive reclaimed marshes, reedbeds and water meadows. To the north and south, the reclaimed pastures at Keysworth and The Moors respectively are protected from tidal inundation by low earth embankments which date to before 1800, but which, together with the system of ditches and sluices, have been modified in recent years.

To the west the reed-fringed rivers flow through a low-lying landscape of marshes and water meadows. Brackish water extends into the Frome beyond Wareham Bridge for short periods on high spring tides (Ranwell *et al* 1964) and the Piddle is tidal beyond North Bestwall.

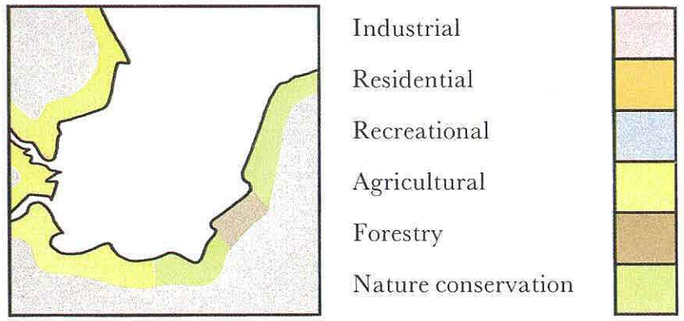
To the east the intertidal area consists of extensive and often very soft mudflats. These reflect a long history of progressive silting which led to the decline of Wareham as a port by the mid-sixteenth century and which was accelerated by the arrival of *Spartina* in the upper estuary in the early 1900s. The fringe of reedbeds is indicative of brackish water conditions (*Phragmites* is limited in Poole Harbour to soils whose salinity does not exceed 2%) and includes the Arne Reedbed National Nature Reserve. The eastern edge of the upper estuary, where the Bagshot deposits reach the shore, is marked by beaches with erosional features.

The high numbers and diversity of bird species in the upper estuary can be attributed to the relative lack of disturbance and the variety of feeding grounds and habitats. Among the waders, curlew, redshank, and black-tailed godwit have relatively high populations, whilst the area is the most important in the Harbour for lapwing, common snipe and ruff. Waterfowl numbers are naturally high and the area around Gigger's Island contains the largest night-time gull roost in the Harbour, at times reaching 20,000 individuals.

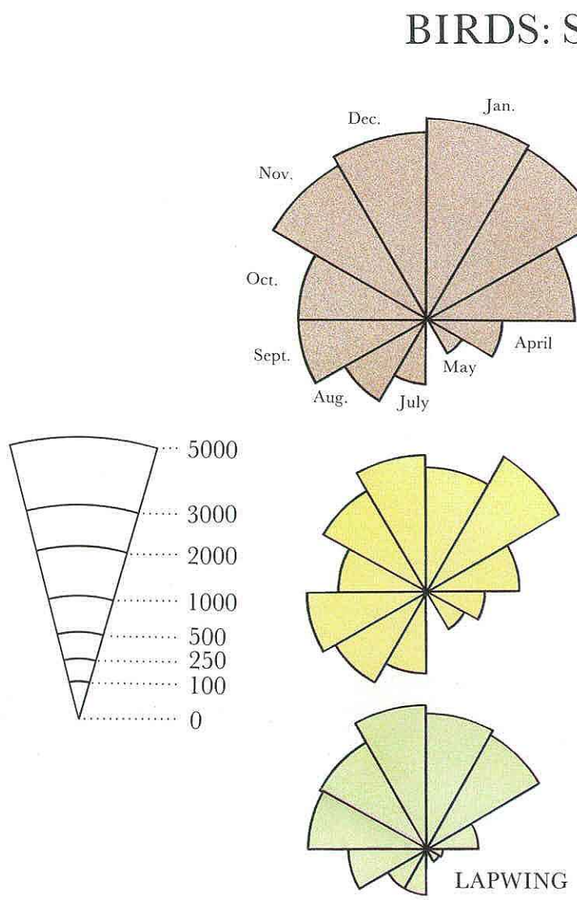
ECOLOGICAL SENSITIVITY



LAND USE



BIRDS: SEASONAL VARIATION



INTERTIDAL

The spectrum of species using the intertidal areas reflects the dominance of mobile muds and, above the tidal limit, the presence of seasonally-flooded meadows and marshes crossed by many ditches. Long-billed wader species, which feed in the fields and intertidally, predominate with curlew (230), black-tailed godwit (120) and redshank (390) all occurring in numbers which may exceed 20% of their Poole Harbour population. The average high count of 50 common snipe, which feeds mainly in the reclaimed marshes but also occurs in the saltmarsh, represents around 70% of the Harbour total. As in the Keysworth area to the north, the numbers of waterfowl may be high, with teal (215) and wigeon (295) at around 15% of their Harbour totals.

GULLS

Black-headed gulls, which feed inland along the river valleys, occur in large numbers (c. 1000) and the area supports the largest night-time gull roost in the Harbour. During observations made in November 1984, around 7500 gulls, mainly black-headed gulls but with c. 250 herring gulls and probably small numbers of other species, collected at dusk around Gigger's Island and along the Wareham Channel. This traditional roost may reach up to 20,000 gulls (Prendergast & Boys 1983)

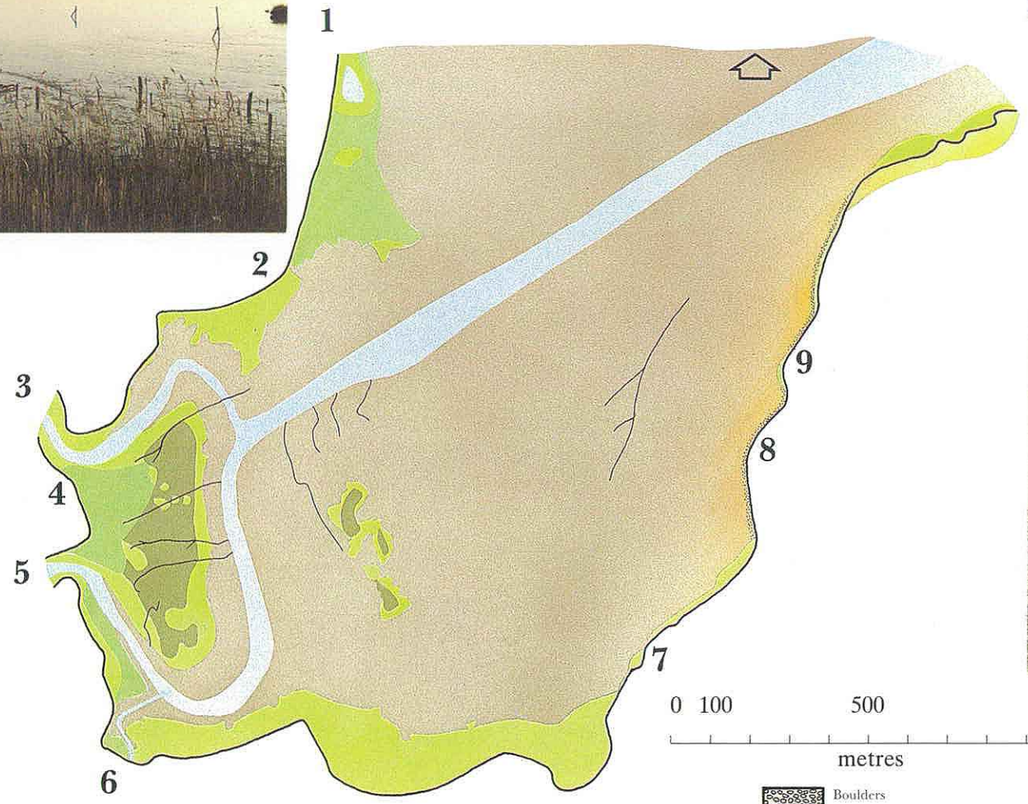
A variety of other species found in the upper estuary may ultimately be affected by oiled marshes and reedbeds. They include heron and lapwing, the Poole Harbour population of the latter species being concentrated in this area (1135, c. 80% of the Harbour total). The entire Harbour population of ruff (59) is found here and at Keysworth to the north, and other winter visitors such as Bewick's Swan and white-fronted goose may occur.

Of the diving birds red-breasted merganser (39) and cormorant (32) may exceed 15% of their Harbour total.

7. Upper Wareham Channel

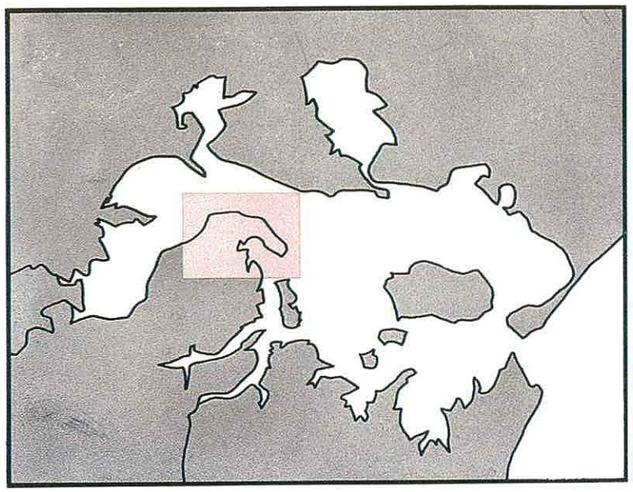
From Keysworth Point (1) southwards the saltmarsh is dominated by *Puccinellia maritima* with *Spartina anglica* as a major component. An erosion cliff up to 75cm high separates the edge of these marshes from fluid mud to seaward (right). The fringing vegetation changes to reedbed at the bend in the bank east of Buck's Cove Island (2, and below right). To landward a series of earth embankments, some recently repaired, separate the marshes from extensive areas of reclaimed grassland.

North of Hyde's Quay the Bagshot deposits of Arne Heath reach down to the tidal limit and a narrow fringe of sand and gravel beaches, with patches of reed and upper saltmarsh, occurs below often tall cliffs. These generally eroding beaches (photographed at 8, below; and 9, above) are replaced at midtide level by soft sandy muds and muds.



Reedbeds are the predominant vegetation fringing the mudflats, west of a line from Buck's Cove Island (2) to Hyde's Quay (7). This includes the edges of the River Piddle (3), the northern bank of which has particularly extensive reedbeds (top left), the grassland and marshes around Swineham (4, and middle left), the banks of the River Frome (5), seen bottom left near Ridge Wharf, the edges of Gigger's Island, and along the southern shore from Turner's Cove (6) to Hyde's Quay (7). The last is an extensive area which includes the Arne Reedbeds National Nature Reserve (right). The reeds generally have soft mudflats to seaward and are backed by grazing marshes, tidal saltmarshes (at Swineham) and water meadows to landward. Although the ancient reclaimed marshes have largely been drained, some areas of *Juncus*-dominated wetlands with brackish-marsh plant species remain.

8. North Arne

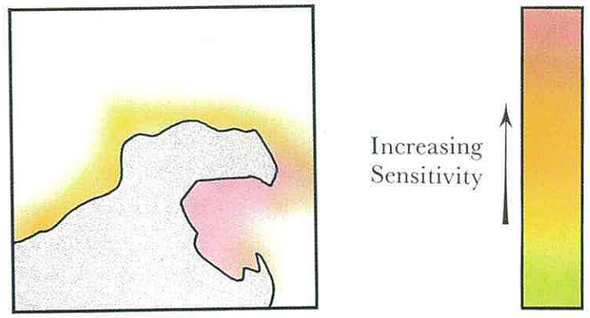


The two sides of the northern tip of the Arne peninsula provide a contrast in sediment and shoreline types. Along the west and north shores sand and gravel beaches, backed by cliffs and wind-blown sand, reveal a high energy shoreline. Beach material from the cliffs has been carried eastwards beyond Gold Point, where it protrudes as a cuspate foreland, to form a long spit, recurving at its tip (Patchins Point) and within which marshland developed before the advent of *Spartina*.

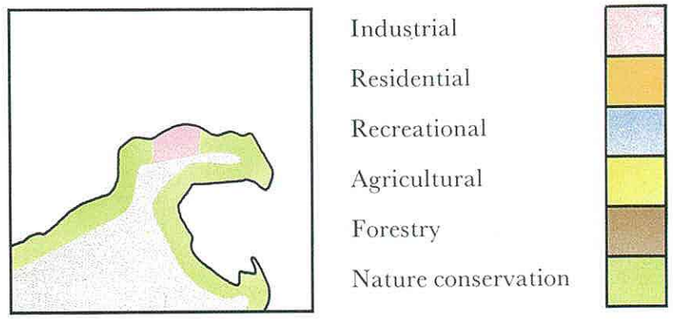
In contrast, on the eastern shore are the sheltered tree-lined marshes and mudflats of Arne Bay. Protected by Patchins Point to the north and a spit which has grown northwards from Shipstal Point cliff in the south, the Bay was colonised by *Spartina* around 1900 and became an important area for the export of the grass. Largely through the efforts of Mr R Cartridge, around 175,000 *Spartina* fragments and many seed samples were exported from Poole Harbour between 1924 and 1936 alone; Arne Bay being a key area (Hubbard 1965). Exported to more than 130 sites around the world, the grass was used for land reclamation and sea defence programmes. Today the area of *Spartina* in the Bay has declined and much of the lower marsh has an erosion cliff at the front of the sward. Despite this, the sediments to seaward of the marshes, and of the steeply shelving sandy beaches along the north shore, consist largely of very soft muds.

The shorelines are generally remote from public access from the land, and form part of the Arne Nature Reserve of the Royal Society for the Protection of Birds. Added to this the variety of shoreline types and near-shore habitats, ensures a high diversity of bird species. The most numerous wader is the oystercatcher, at times the area holding more than half the Harbour total, but species as different in their requirements as turnstone and curlew occur in relatively high numbers. The Arne Bay-Patchins Point area is important for shelduck and other waterfowl and the water to the east contains good populations of diving birds and a night-time gull roost.

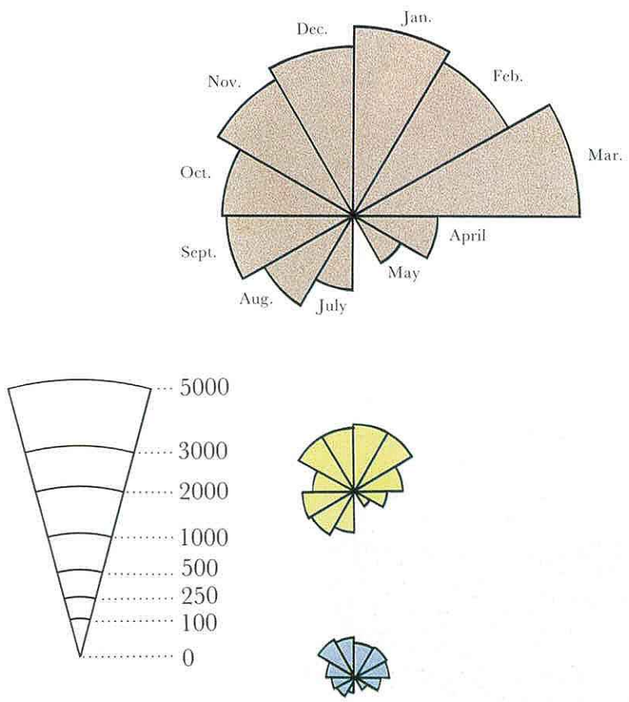
ECOLOGICAL SENSITIVITY



LAND USE



BIRDS: SEASONAL VARIATION



INTERTIDAL

The variety of shoreline types is reflected in the numbers and diversity of species counted in this area. The most numerous intertidal species is the oystercatcher; the average high count of 555 representing around 54% of the Poole Harbour total. The highest numbers generally occur in Arne Bay but oystercatchers are well scattered around the area. In contrast, almost all of the turnstone (14, equivalent to 35% of the Harbour total), ringed plover (29 ≡ 20%) and grey plover (13 ≡ 8%) have been recorded along the north shore east of Gold Point, and all of the black-tailed godwit (51 ≡ 9%) within Arne Bay. Curlew (267 ≡ 25%) are rather more scattered but mainly occur in the Patchins Point area, whereas greenshank (14 ≡ 36%) are most common on the north shore west of Gold Point. Of the ducks, shelduck (404 ≡ 17%), wigeon (215 ≡ 12%) and teal (139 ≡10%) occur mainly in the Arne Bay-Patchins Point area.

GULLS

Gull numbers are relatively low on this section of shoreline, the most notable feature being the relatively high numbers of herring gull. However, a large night-time gull roost (c. 5,000 black-headed gulls) was observed in November 1984 on the open water west of Arne extending towards Brownsea Island.

DIVING BIRDS

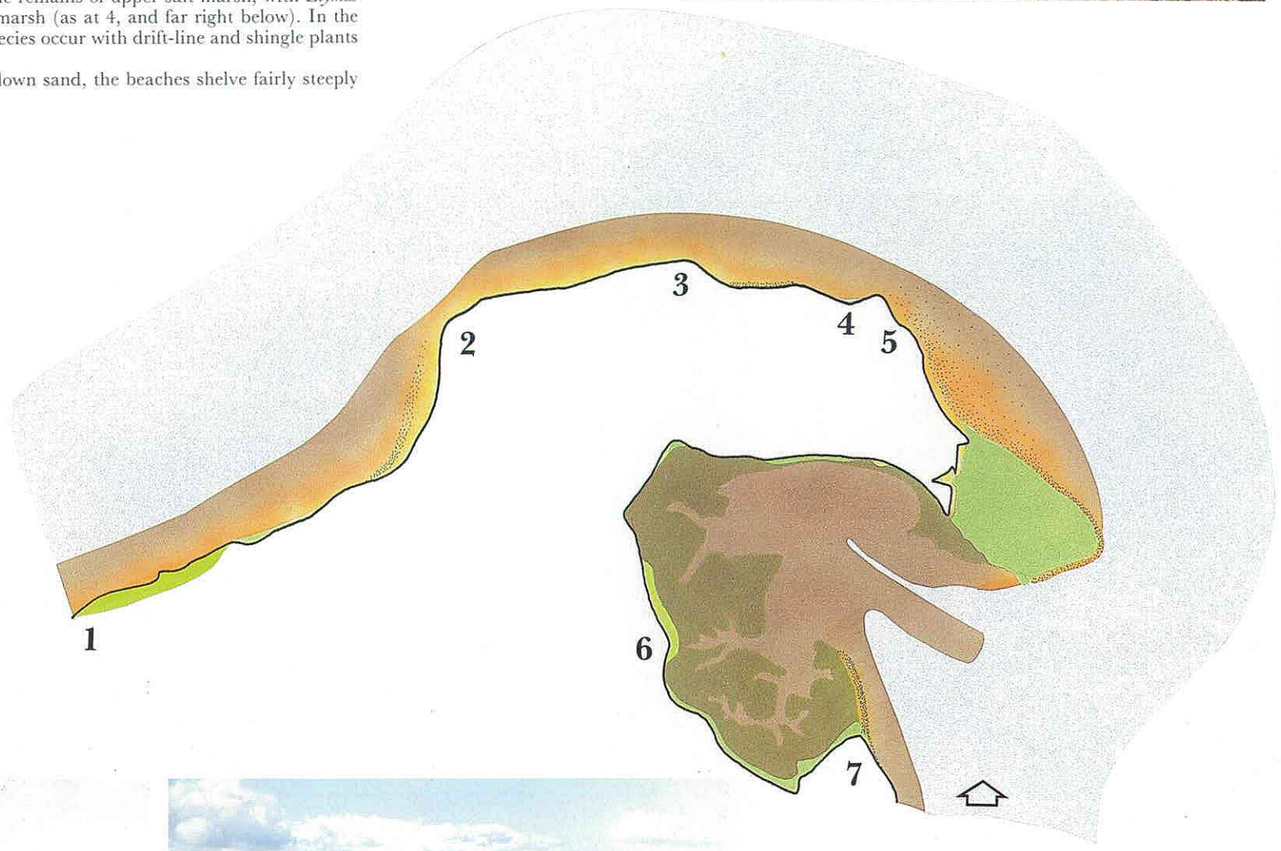
Diving birds occur offshore in small, but significant numbers, with both cormorant (46) and red-breasted merganser (60) reaching at times around a quarter of the Harbour average total. The area also holds proportionally high numbers of great-crested grebe and goldeneye.

8. North Arne

From the eastern edge of the reedbeds at Turford (1) to Russel Quay (2) a sand and shingle beach is backed to landward by an eroding cliff of the Bagshot deposits underlying Arne heath (below, looking south). Seaward of the beach muddy sands grade into muds exposed at low spring tides. At Russel Quay (near right), along the north shore to Gold Point (5), and beyond to the tip of Patchins Point, the dominant beach type is sand and shingle.

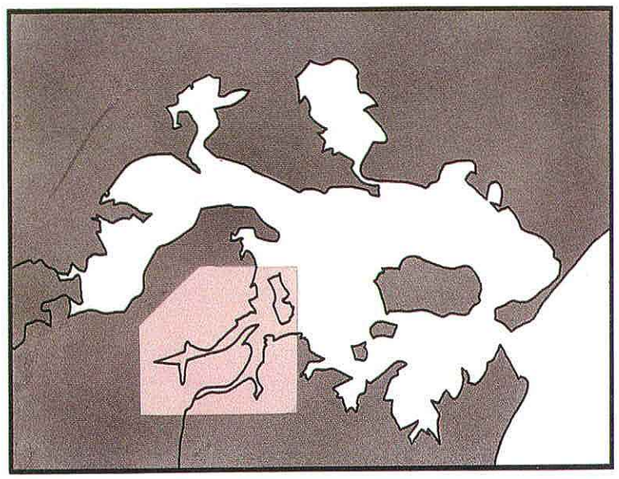
Above high tide level in many areas a sand dune vegetation type, with *Ammophila arenaria* and *Carex arenaria*, has developed on wind-blown sands. The beaches may be narrow and shingle-covered or relatively wide and sandy, as below the bund screening the clayworks (3, and far right above). In other areas are found the remains of upper salt marsh, with *Elymus pycnanthus* or *Juncus maritimus*, and even *Spartina* marsh (as at 4, and far right below). In the beach extending down to Patchins Point dune species occur with drift-line and shingle plants such as *Suaeda vera* and *Beta maritima*.

Whether backed by low eroding cliffs or wind-blown sand, the beaches shelve fairly steeply down to gravelly muds and soft muds.

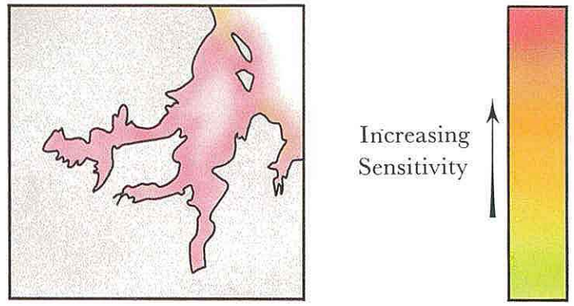


Arne Bay (below left), encircled by woodland extending down to the shoreline, is flanked by the saltings of Patchins Point to the north and a sand and shingle spit projecting northwards from Shipstal Point in the south (7, and below right). The *Spartina* marshes carry a small cliff at their outward edge and show transitions via reed, *Scirpus maritimus*, *Juncus maritimus* and other brackish communities to acid wetland in the woods at the upper edge. Pools on the marsh contain *Ruppia spiralis*. Boreholes along a transect at 6 revealed around 70 cm of sediment deposited since the advent of *Spartina* (Bird and Ranwell 1964). Seaward of the marsh cliffs and the shingle spit are very soft muds.

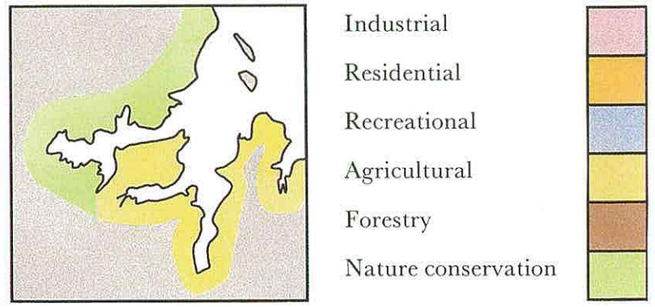
9. Middlebere & Wytch



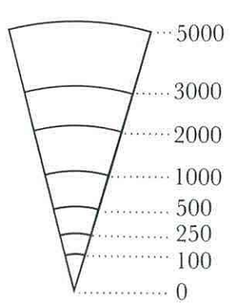
ECOLOGICAL SENSITIVITY

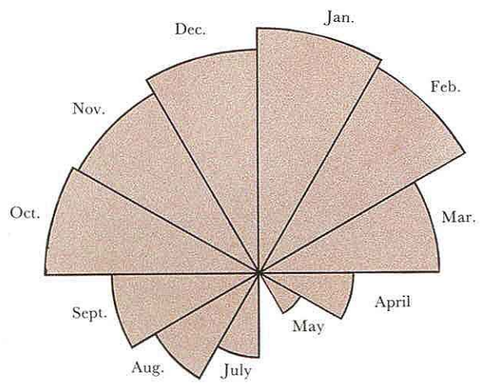


LAND USE



BIRDS: SEASONAL VARIATION



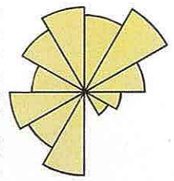


Flanked by the Arne peninsula to the west and Fitzworth to the east this section of the Harbour includes the inlets of the Middlebere and Wytch channels. These channels or streams, whose confusing local name is 'Lakes', unite to the west of Round Island to form the Wytch channel, and, at low water ebb tides, flow northwards between Long Island and Shipstal Point. Apart from the Corfe River, the Lakes drain local bogs, heathland and farmland, and there are many freshwater springs around the shoreline. Consequently, there is little scour and the predominate intertidal landscape is one of saltmarsh and brackish wetland fronted by deep soft muds.

To landward of the marshes a variety of transitional vegetation types occur. These include, in the low-lying areas, brackish swamps, reed beds, willow carr, rush-dominated and acid wetlands, and, on natural rises in the land, dry grassland, heathland, scrub and woodland. Except for a few artificial embankments, such as the concrete sea wall in front of private residences at Shipstal, and various earth banks around minor reclamations elsewhere, the transitions to terrestrial habitats have remained largely unmodified – particularly along the edge of the Arne peninsula. The main concentration of arable land is between the 2 inlets and around Wytch Farm. In several places, notably along the Fitzworth Shore, the marshes are grazed by cattle, horses and sheep with access from pasture on higher ground nearby. Locally small sand and earth cliffs, sometimes with a small beach at the toe, occur at the landward edge of the marshes, and the low-lying bluff which marks the maximum extent of the post-glacial Marine transgression is apparent along parts of the shoreline.

The Arne shore is part of the Royal Society for the Protection of Birds nature reserve and the remaining area is agricultural land (owned privately or, at Middlebere, by the National Trust). In addition, there are few, even minor, roads close to the shoreline and the natural terrain makes access difficult. Consequently the mudflat and wetland areas remain relatively undisturbed and are important areas for waders and waterfowl.

Footnote: In the data available to us, the number of birds counted on each side of Fitzworth point had been pooled. This gave a figure for Wytch Lake plus the central part of the south shore between Round and Green Islands including Ower Bay and the mainland down to Cleavel Point. This area, which holds large populations of several species, straddles the division between sections 9 and 10 in this report. The diagrams giving seasonal variation in bird numbers for each of these sections have therefore been constructed on the assumption, not equally reasonable for all species, that birds are evenly distributed around Fitzworth Point. Some known concentrations of certain species within the Arne to Goathorn sections have been high-lighted (*eg* black-tailed godwit in Newton Bay, spotted redshank at Middlebere), but it would be misleading to calculate the proportion of the Harbour totals which the separate 'totals' for sections 9 and 10 represent. In fact, for several species a very high proportion of the Harbour total is reached when these totals are combined – emphasising both the importance of the Arne to Goathorn section of shoreline for intertidal species, and the need to investigate in more detail how it is used by different species.



INTERTIDAL

Particularly numerous among the overwintering waders using this section of the Harbour are curlew, redshank, dunlin and black-tailed godwit. The first three are fairly evenly distributed around the area, although curlew tend to occur in higher numbers in the more seaward part of Middlebere and around Fitzworth Point. Black-tailed godwit, however, occur in greater numbers in the upper part of Middlebere Lake (as well as around Fitzworth). This upper section is also important for spotted redshank, less frequently observed – the mean highest count of 23 in the sector west of Middlebere jetty representing nearly 60% of the Poole Harbour population (see Footnote).

Among the duck which may feed or roost in the intertidal area are wigeon and shelduck, in the more seaward sections, and teal and pintail, more widely distributed into freshwater areas. For the Poole Harbour population of these four species (and the Brent goose), the southern shore from Arne to Goathorn is the most important area (see Map 10).

GULLS

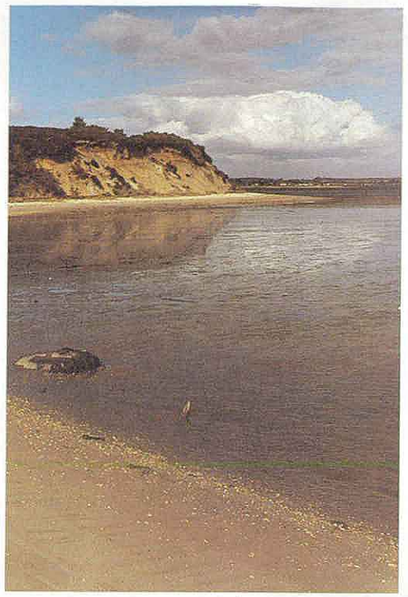
Gull numbers within this section of shoreline are comparatively small, *eg* average high counts of 30 and 80 black-headed gulls for the north and south Middlebere sections respectively.

RED BREASTED MERGANSER

Red-breasted merganser numbers are relatively high, the average high count of 34 for Middlebere representing almost 15% of the Harbour population.

9. Middlebere & Wytch

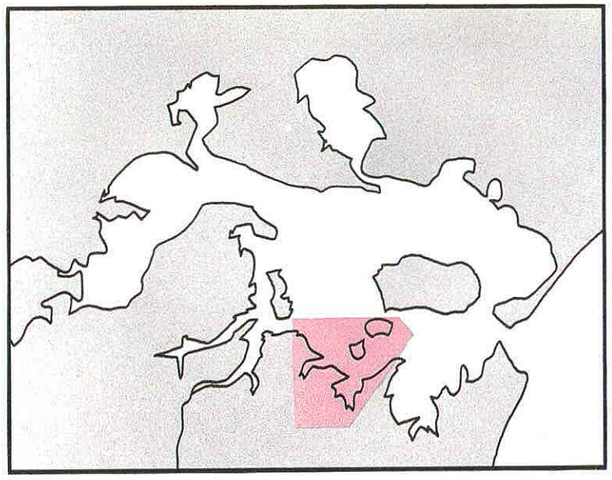
The sand and gravel beaches around Shipstal Point (1, and right) and on the northern edge of Long Island (2) provide a marked contrast with the very soft muds immediately to seaward. With the exception of a few gravelly mud beaches, for example south of Grip Heath at 3, these soft muds occupy the intertidal area below the marshland fringe around the whole of this section of shoreline. *Spartina* marsh, invaded by *Halimione portulacoides* and other species, is the most common marsh type. In the more seaward areas, and around the islands, the marsh is separated from the mudflats by a small cliff, but upstream, along the arms of the Middlebere and Wytch lakes, clones of *Spartina* and reedswamp species extend down to the flat mud surface (see the photograph at bottom left looking west along Middlebere Lake from 6 towards the old jetty at Middlebere Quay).



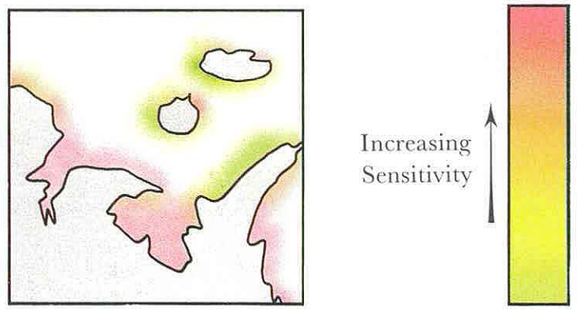
At the landward edge of the marshes transitions occur to a wide variety of vegetation types. Such transitions are modified in some areas by earth embankments and drainage ditches, ancient and recent, as around the northern arm of Middlebere Lake (4) draining Salterns Copse and Slepe Moor. The southern arm, draining Hartland Moor via the stream under Slepe Bridge (5). contains a natural and species-rich transition from *Spartina* marsh through reedbed and brackish grassland communities with *Scirpus maritimus*, *S. tabernaemontani* and several species of *Juncus*, *Carex* and *Eleocharis*, to acid wetland with *Molinia caerulea*, *Schoenus nigricans* and *Myrica gale*.

Wytch Lake receives the Corfe River (7) and its margins include both pasture and arable land. The eastern arm, draining Wytch Moor has extensive wetland margins (in lowest photograph above looking south from Nath Point (8)). The marshes may be grazed, by cattle or sheep, the effect (seen above centre near Fitzworth Farm (9)) being to eliminate many broad-leaved species, such as *Halimione portulacoides*, in favour of grass and rushes. The very soft muds to seaward of the outer marshes occasionally carry an extensive growth of green algae, principally *Ulva lactuca* and *Enteromorpha* species (seen above top viewed from Fitzworth Point north to Round Island (10)).

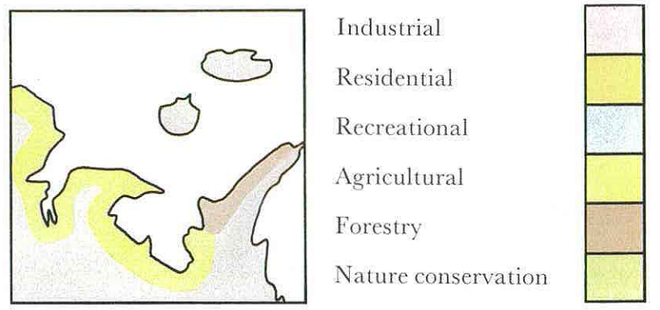
10. Central Southern Shore



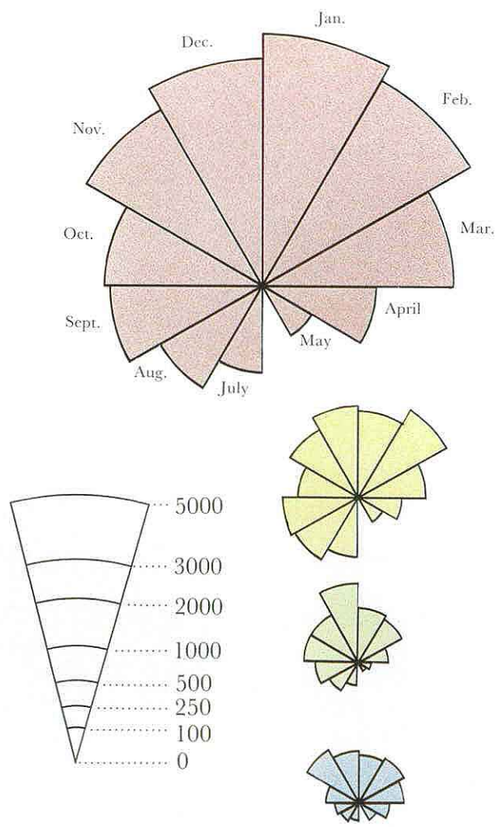
ECOLOGICAL SENSITIVITY



LAND USE



BIRDS: SEASONAL VARIATION



The central part of the south shore between the promontories of Fitzworth Point and the Goathorn peninsula is a topographically and physiographically complex section of the Harbour. It includes the inlets of Ower and Newton Bays and, to seaward, Green Island and Furzey Island, marsh-fringed and wooded elevations of Bagshot sands and clays partly capped with gravel.

The site of the first record of *Spartina* (at Ower around 1890; Hubbard 1965), the intertidal area has been considerably changed by the rapid spread of this grass in the early part of this century, and its subsequent decline. Recently the regression of *Spartina* marsh has been particularly notable, with more than 100 hectares (approximately two thirds of the 1952 area) having been lost from the area east of Fitzworth Point and south of Brownsea Island in the last 30 years (Gray & Pearson 1984). However, remnants of these once extensive marshes occur as a shoreline fringe and as many islets of irregular shape and size. In the west they overlie soft mudflats but in the east, and around the islands, mudflats too have disappeared to be replaced by coarser sediments. Along the edge of the Goathorn peninsula and extending into Newton Bay, is a wide flat beach of muddy sand and sand. Firm to walk on, more than 50 metres seaward of the high tide level, parts of this shore consisted of soft and dangerous mud less than 15 years ago.

In the west the marshes are backed by a low bluff, eroded in places with relic beaches at the base. Most are grazed by sheep or cattle which have access from nearby pasture. Transitions to swampy ground occur along the inlets. Newton Bay is ringed by trees and along the Goathorn peninsula cliffs of Bagshot material at the top of the beach are topped by dense woodland.

The remoteness, complex topography, and diversity of feeding grounds make this section of shoreline particularly attractive to overwintering waders and wildfowl. If disturbed, feeding birds may settle nearby in the shelter of a promontory or island or among the islets of *Spartina*. There are large populations of dunlin, oystercatcher, redshank, curlew and, particularly notable, black-tailed godwit. This last species feeds especially in Newton Bay where the mudflats, exposed early in the falling tide, are visited also by wigeon and shelduck. The nearby fields at Fitzworth and Cleavel Point provide grazing for Canada geese and may be used by Brent geese, the main Harbour population of which is found among the marshes, mudflats and islands in this area.

INTERTIDAL

This section of shoreline holds major populations of several species of inter-tidal waders. Including Wytch Lake to the west (see the Footnote to the section on birds on Map 9) and the seaward edge of the *Spartina* patches between Long and Furzey Islands, the area may support around a fifth of the Poole Harbour populations of dunlin and oystercatcher, a third of the grey plover, half of the redshank, more than two thirds of the curlew, and four fifths of the black-tailed godwit. This last species feeds particularly in Newton Bay, the average high count of 210 representing 40% of the Harbour total.

Large numbers of wigeon and shelduck also feed in Newton Bay but these species are widely distributed among the mudflats and marshes (their Wytch Lake to Goathorn totals being 45% and 50% respectively of the Harbour population).However, the area is particularly important for the Brent goose, carrying almost 80% of the Harbour total. The numbers of this species, which feeds intertidally and in nearby fields, have risen dramatically in the past decade, both in Poole Harbour and in other British estuaries.

GULLS

The central part of the south shore supports a relatively small gull population. However, a night-time roost of more than 1400 gulls, mostly black-headed gulls, was counted in the area east of Fitzworth Point in November 1984.

CANADA GOOSE AND LAPWING

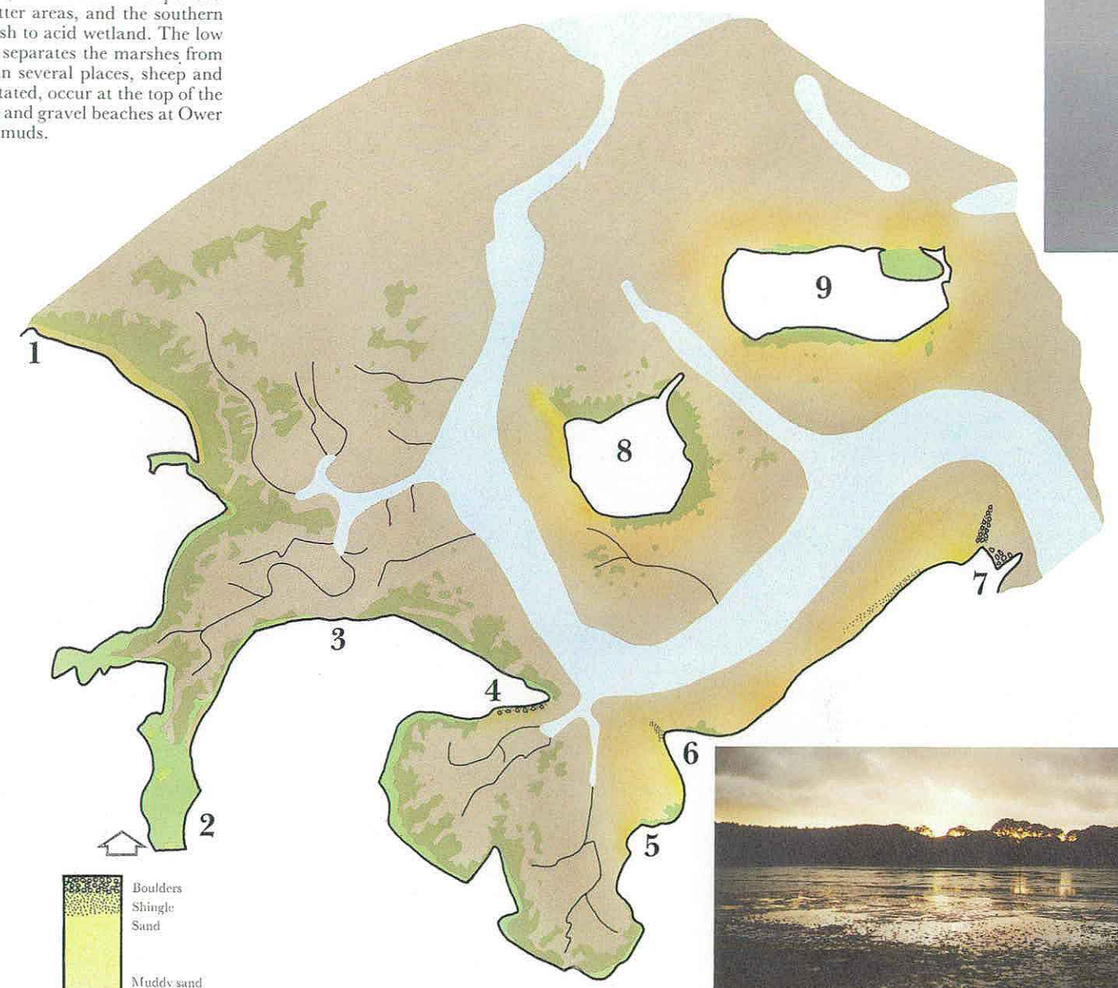
Canada goose and lapwing feed and roost in the fields bordering the shoreline, notably around Fitzworth and Cleavel Points. The numbers of both species reach around 20% of their Harbour totals.

DIVING BIRDS

The area north of a line from Furzey to Long Island and south of a line from Brownsea to Patchins Point (which includes the deeper water of the Wytch Channel) contains proportionally large numbers of several diving birds. More than half of the Harbour total of scaup and a third of the Harbour total of goldeneye and great-crested grebe may occur there. Red-breasted merganser and cormorant tend to occur more widely, the former being found along the Middlebere and Wytch Lakes and even into Newton Bay.

10. Central Southern Shore

To seaward of the salt marshes fringing the shore from Fitzworth Point (1) to Cleavel Point (4) islands of *Spartina* overlie soft mudflats (on which extensive algae growths may occur, as below). The marshes often have a small cliff, carrying *Fucus* species, at their leading edge (below centre). To landward they are replaced in the drier grazed areas by *Festuca rubra* and *Agrostis stolonifera*-dominated vegetation with *Armeria maritima*, a common component. *Juncus maritimus* and *Scirpus maritimus* frequently occur in the wetter areas, and the southern arm of Ower Lake (2) carries a transition through brackish marsh to acid wetland. The low bluff, which marks the upper limit of the Marine transgression, separates the marshes from fields to landward, most of which are grazed and from which, in several places, sheep and cattle have access to the salt marsh. Sandy beaches, usually vegetated, occur at the top of the marsh where the bluff has been eroded but, apart from small sand and gravel beaches at Ower Quay (3) and Cleavel Point, the intertidal sediments are very soft muds.

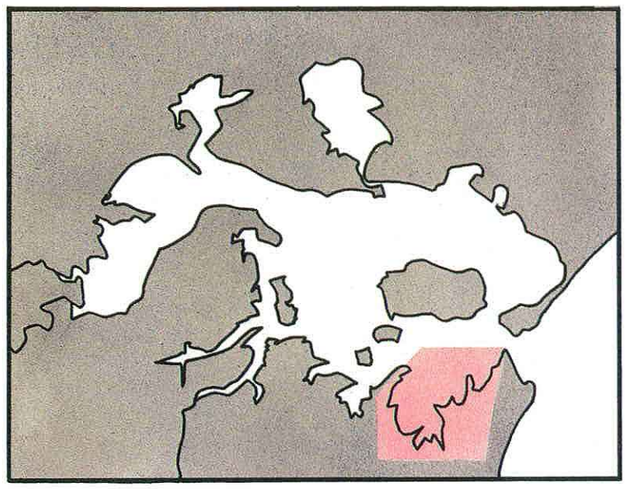


Both Green Island (8) and Furzey Island (9) have diverse shoreline types. Their western edges, exposed at high tide to wave action generated by the prevailing winds, carry tall cliffs of Bagshot sands (above). On Furzey Island, sand and gravel eroded from cliffs along the south-east and north-west shores has drifted eastwards. The southern spit curves northwards to the jetty and encloses an area of salt marsh in the north-east corner. Apart from these small sheltered areas of accretion (there is a smaller marsh on the north-west of Furzey Island and along the north and east of Green Island) the predominate intertidal sediment types are sands and muddy sands. These are overlain by remnants of mudflats and *Spartina* marshes, which formerly extended more than 1 kilometre eastwards from Furzey Island.

The western half of Newton Bay, except that it is lined by trees, presents a similar landscape to that further west – very soft mudflats with islands of *Spartina*, and a fringe of marsh grading into *Juncus maritimus*, *Scirpus maritimus* and *Festuca rubra* (seen lower left viewed southwards from Cleavel Point). Along its eastern edge, however, (5, near left) the muds become firmer and sandier, and from the spit of gravel at Hill Point (6) a wide beach of firm muddy sand extends north-eastwards to the tip of the Goathorn peninsula (7). The beach merges into sandy muds and softer muds to seaward. Isolated mud mounds (above) and eroding *Spartina* marsh at the upper edge are remnants of the former marshes and mudflats.

Transitions to oak woodland via brackish communities, with *Scirpus maritimus*, *Juncus maritimus* and *J. gerardii* notably common, are replaced north of Hill Point by sand and shingle beaches, interspersed with patches of eroding salt marsh. These beaches are backed along the Goathorn peninsula by sand cliffs up to 10 metres high and topped by woodland. At the tip of Goathorn a boulder-strewn beach below the pier and a tongue of gravel to the west enclose a small muddy bay with isolated clumps of *Spartina*.

11. Brands Bay

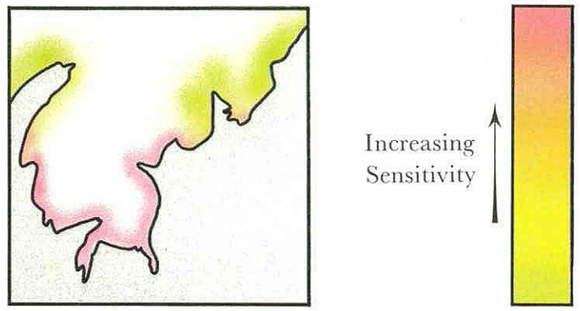


Brand's Bay, the most seaward inlet along the Harbour's south shore, has a much-indented shoreline with several minor bays and promontories. The western edge is lined by dense mixed woodland, with conifers common in the north and deciduous species in the south. The southern bay presents a more pastoral landscape with small fields, both grazed and arable, around the upper shore, and gorse hedges and lines or small copses of willow, oak and other trees. At the inlet of the stream from Studland Heath, the landscape changes again, the east of the bay being fringed by almost treeless heathland with sand dunes at the northern tip.

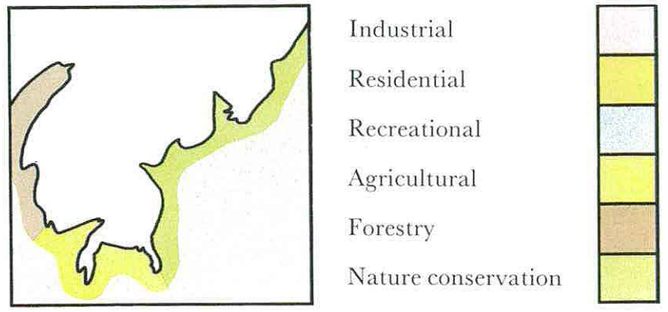
The intertidal sediments grade from firm, often wave-rippled sands at the mouth of the bay to very soft muds among the *Spartina* marshes in the south. Gravel beaches and shingle ridges are common along the northern shores, where there is much evidence of recent erosion. Large areas of *Spartina* marsh have been lost in recent years from this part of the bay. Islets of *Spartina* and mounds of firmer mud are all that remain and the recession of these marshes appears to be continuing, with the swards on soft accreting muds in the south showing signs of dying back (see photograph on map page). Upper beach profiles include degraded cliffs covered with gorse and heathland vegetation, and eroding cliffs of sand, clay and gravel (up to 4 metres high along the Goathorn shore, and north of Redhorn Quay along the east shore). Occasionally a double cliff occurs, that in the heathland being separated from one lower down by a plateau of marshland, *eg* around Bramble Bush Bay. A wide variety of transitional plant communities occurs between the salt marsh and heathland (many of them known to be rich in species). Easy access from the Studland Ferry road makes the east shore popular with visitors, particularly in the north. This area is the only part of the south shore of the Harbour regularly dug for bait (mostly around Jerry's Point); six houseboats are permanently moored south of Gravel Point, and the beaches are used by anglers and, particularly south of the ferry where there is a café at the boatyard, by large numbers of summer visitors.

The winter bird population of the Bay contains relatively high numbers of several intertidal species, including black-tailed godwit, shelduck, Brent goose and curlew – all at levels which may exceed a third of their Harbour total. Redshank, dunlin and wigeon are also common and the rarer greenshank is a notable visitor in small numbers. The area of Stone Island Lake to seaward of the bay is important for diving birds, especially the red-breasted merganser.

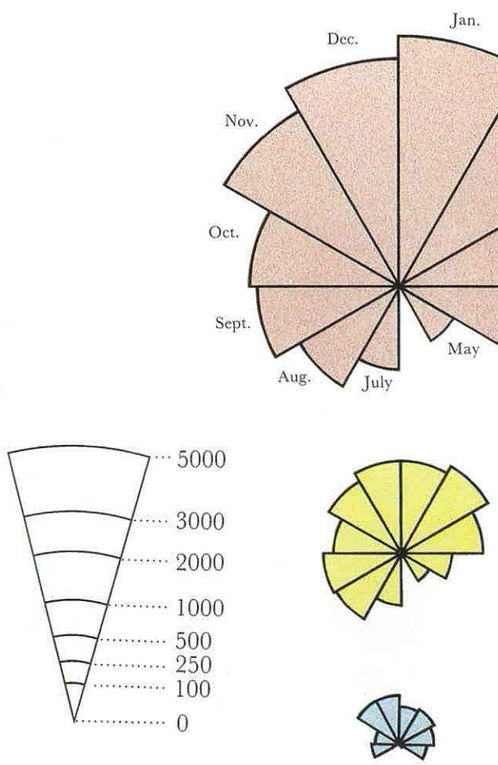
ECOLOGICAL SENSITIVITY



LAND USE



BIRDS: SEASONAL VARIATION



INTERTIDAL

Several of the intertidal species which are common along the south shore to the west occur in large numbers in Brand's Bay, particularly along its western edge. That they probably move freely between here and nearby Newton bay is evidenced by the similarity in concentrations of black-tailed godwit and shelduck. The southern part of Brand's Bay, below a line from the tip of Goathorn to Jerry's Point, may support around 40% of the Poole Harbour population of these conservationally-important species (see 4). Curlew (365 ≡ 35% of the Harbour total) and redshank (322 ≡ 23%) occur mainly in the west and this area is one of the few in the Harbour where greenshank may be found in relatively high numbers (21 ≡ 4%). Dunlin and bar-tailed godwit, whose Poole Harbour populations are centred at nearby Studland and Sandbanks, respectively, may occur in relatively high numbers. Of the intertidal waterfowl, Brent goose and wigeon, with similar feeding requirements, occur in high numbers in the southern bay (270 ≡ 40% and 219 ≡ 13% respectively).

GULLS

The bay does not hold particularly large gull populations, although a small night-time roost (> 200 birds of all species) was observed in the western area in November 1984. However, the seaward part, including Stone Island Lake and extending to the south shore of Brownsea, may contain a third of the Harbour's herring gulls.

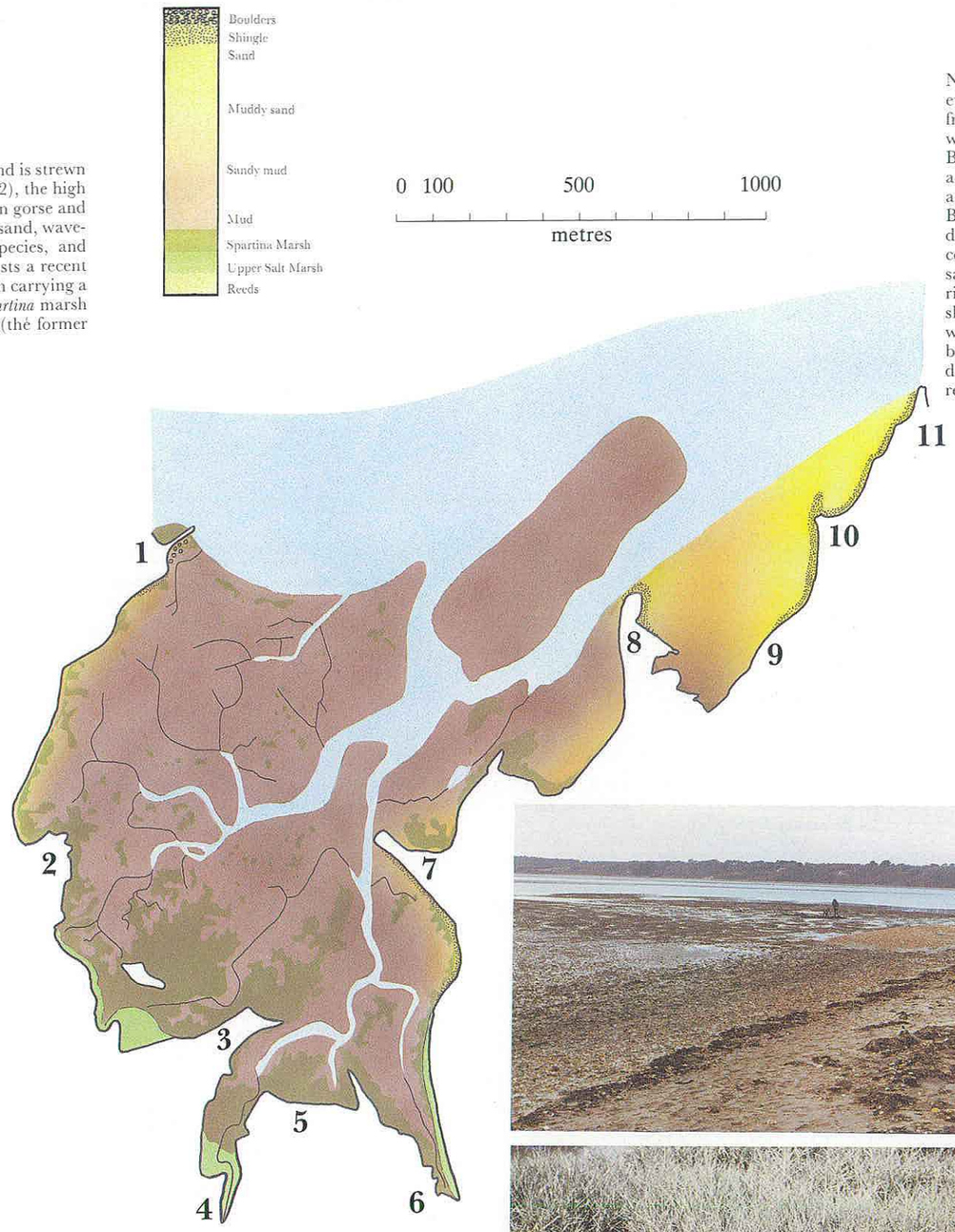
RED BREASTED MERGANSER

The Stone Island Lake area is also important for the fish-eating species of divers. In particular, an average high count of red-breasted mergansers of 128 for this area plus the lower part of Brand's Bay, represents more than half of the Harbour's total.

11. Brands Bay

Below the stone pier at the tip of the Goathorn peninsula (1), a beach of muddy sand is strewn with *Fucus*-covered boulders. Southwards, down to the bay north of Water Point (2), the high tide limit is marked by a cliff, up to 4 metres high, largely degraded and covered in gorse and bracken scrub. To seaward, the upper beach is a mosaic of sand and gravel or fine sand, wave-rippled sands, patches of eroded mud with *Limonium vulgare* and *Salicornia* species, and clumps of *Scirpus maritimus* or *Juncus maritimus* (below). This curious mosaic suggests a recent predominance of erosive forces, particularly in the north where a wide sandy beach carrying a dense stand of *Suaeda vera* has developed below an eroding cliff. The fringe of *Spartina* marsh along this edge widens in the south. Islets of *Spartina* and patches of firm mud (the former sites of *Spartina* clumps) are separated by a reticulate pattern of softer mud.

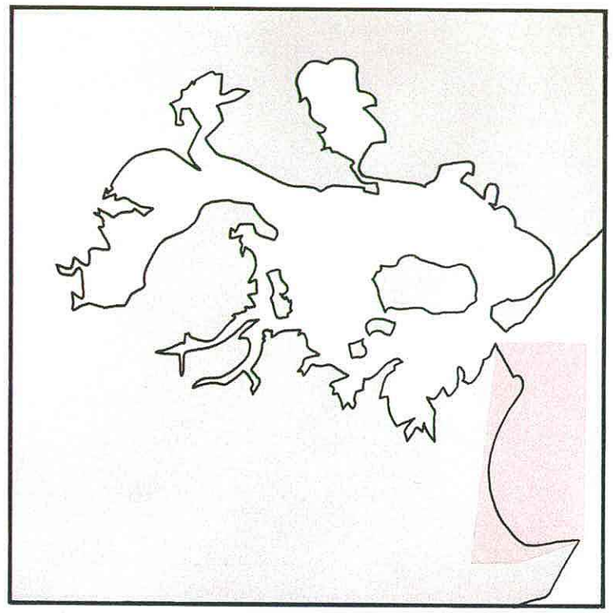
From Water Point to the base of the promontary east of Newton (3), woodland, principally oak, birch and holly, with gorse and *Molinia*, grades seaward in a slight descent to *Juncus maritimus*. This marsh, invaded by willow and birch and containing patches of *Scirpus maritimus*, is more than 50 metres wide below Drove Island (a bracken and gorse covered area of higher ground). Downshore it is replaced by *Spartina* marsh, with *Halimione portulacoides*, below which very soft muds extend down to the low water channels (below, taken at the tip of the promontary at 3).



Northwards from Redhorn Quay, the shoreline presents increasing evidence of recent erosion. The *Spartina* marsh peters out to a thin fringe (too thin to show on the map), the fringe of sand and shingle widens, particularly around Jerry's Point (8), and from Bramble Bush Bay (9) northwards there are many recent erosion cliffs in the low dunes and heathland. The gravel beaches below shingle and dune ridges around Jerry's Point (below left) are dug for bait and the fringes of Bramble Bush Bay are a complex mixture of sand and shingle forelands, deep muds, and both eroding and accreting salt marsh. North of a line of concrete blocks (below right), a firm beach of sand grading to muddy sand and mud down to low water is crossed at Gravel Point (10) by a ridge of shingle and, near the boat park, by boulders and a concrete slipway. North of Gravel Point (immediately below), a flat, firm beach of wave-rippled sand extends north to South Haven Point (11). This is backed by a narrow band of shingle and a steep, sandy beach below dunes and heathland. The eroding shoreline near the café has been recently protected by a bank of loose boulders.

The streams from Greenland(4) and Studland Heath (6) unite to form Redhorn Lake, which flows northwards passing close to the tip of Redhorn Quay (7). Transitions *via Juncusmaritimus* marsh to freshwater marsh (with other *Juncus*species) occur around the edges and in the upper reaches of the streams. Around Mead Point (5) and along the eastern edge to Redhorn is a wide range of saltmarsh communities. The thin fringe of species-rich marsh on the south-east shore shows transitions to acid wet-land and heath communities at the foot of degraded, vegetated cliffs of sand and gravel. To seaward, the fringe of *Spartina* occurs on soft mud, often with a bloom of algae or diatoms (left).

12. Studland Bay



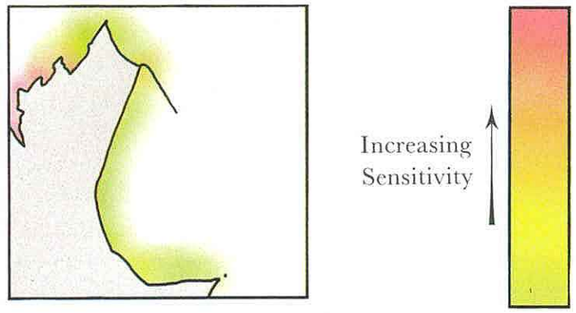
From the Harbour mouth a series of dune ridges runs southwards to Studland where soft cliffs, produced by successive coastal outcrops of the Bagshot Beds, London Clay, and Reading Beds, mark the eastward deflection of the coast along a low chalk cliff to the Foreland. The accumulation of dune ridges seaward of the western spine of Tertiary (Bagshot) sands and gravels has been documented by Diver and others (see section 1 and Carr 1971). It included the enclosure of the now freshwater bodies of Little Sea and Eastern Lake, which drain northwards (aided by artificial drainage) to Shell Bay, an extremely popular holiday beach.

The line of limestone boulders which projects south-eastwards from the eastern end of Shell Bay for almost 1500 metres marks the southern edge of the Swash – the main shipping channel. Since this half-tide training wall was constructed in the 1920s to maintain a navigable approach to the Harbour, sand has accumulated at the northern end of Studland Bay. However, the foredunes in Shell Bay and in the southern half of the Studland dunes have extensive areas of bare sand attributable to heavy recreational use. A car park north of Studland village provides a major point of access for the very large, and apparently increasing, number of summer visitors.

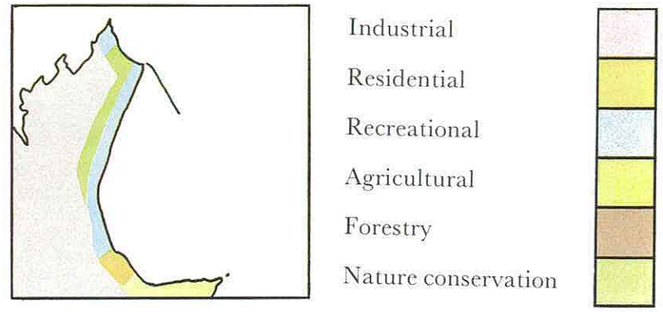
The sandy beaches of the South Haven peninsula, with dunes and heathland to landward, are replaced near Redend Point by a predominantly rocky coast. This is backed at first by eroding cliffs of the Tertiary sandstones and clays and then, extending eastwards, by almost vertical cliffs cut in the Upper Chalk. A sand beach, with shingle and boulders, has developed south of the relatively resistant sandstone promontory of Redend Point, but most of the southern shore of the bay comprises a wave-cut chalk platform with flint and chalk boulders and minor accumulations of sand. This platform continues to the limit of the bay where the Foreland, a mass joined to the main cliff at the turn of the century, and the stacks known as Old Harry and Old Harry's Wife provide well-known landmarks.

The spectrum of bird species found along this shoreline is rather different from that inside the Harbour. Although dunlin is the numerically important species, with more than half of the Harbour total likely to occur (mainly using the high tide roost at Pilot's Point), there are also very high percentages of the local totals of intertidal species such as sanderling and various sea duck, grebes and divers which are rarely found inside the Harbour entrance.

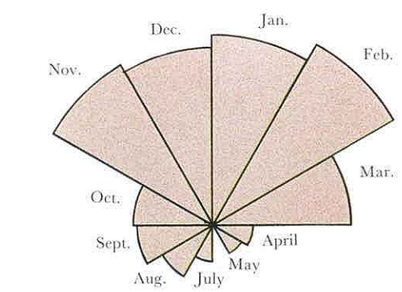
ECOLOGICAL SENSITIVITY

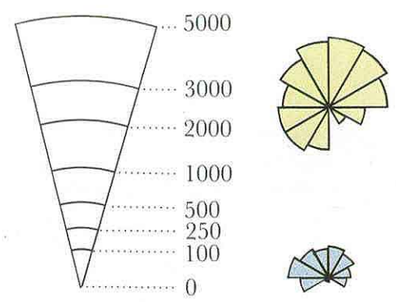


LAND USE



BIRDS: SEASONAL VARIATION





INTERTIDAL

The range of species feeding or roosting in the intertidal zones of Shell Bay and Studland is substantially different from that within the Harbour. Only dunlin and oystercatcher of the major Harbour species occur in reasonably high numbers – indeed, dunlin are numerically dominant with, for example, 2575 of the 2875 figure for intertidal species in February (left). Most of the dunlin in the area are counted at the high tide wader roost at Pilot's Point. Present in much smaller, but proportionally significant numbers, are turnstone (the average high count of 27 being equivalent to 55% of the Harbour population), grey plover (82≡54%) and ringed plover (48≡34%). The area is visited by small numbers of sanderling (10≡91%) which rarely enter the Harbour. Conversely, species which feed in the muddier parts of the Harbour, including the wildfowl, are infrequently seen along its outer shoreline.

GULLS

Gull numbers are relatively low, although more than 10% of the Harbour populations of herring gull, common gull and lesser black-backed gull may occur.

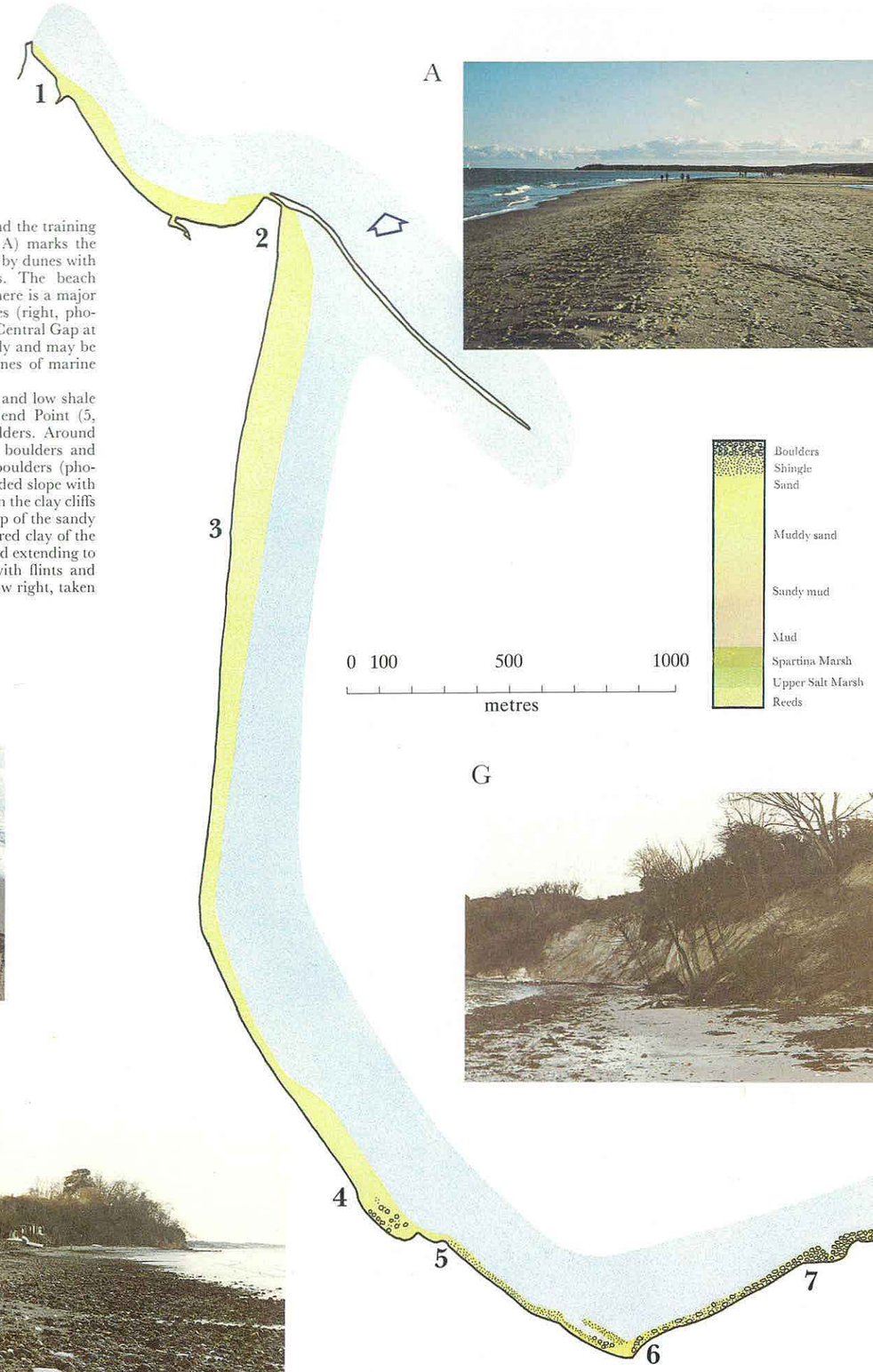
DIVING BIRDS

As with the intertidal species, several diving birds, which winter along the coast and are not normally found inside the Harbour, may visit the outer bay; generally in low numbers. These include common scoter (average high count ≡ 18), eider (47), slavonian grebe (22), black-necked grebe (6), shag (22), and great northern diver, and other diver species. In addition, 33% of the Harbour's great-crested grebe, 23% of the cormorant and 12% of the red-breasted merganser may occur.

12. Studland Bay

Between the stone wall of the chain ferry slipway at South Haven Point (1) and the training bank at Pilot's Point (2) the broad sweep of Shell Bay (right, photograph A) marks the northern edge of the South Haven dune system. A beach of fine sand is backed by dunes with *Ammophila arenaria* and *Leymus arenarius* the major dune-building grasses. The beach continues southwards for more than 3 kilometres to Studland village before there is a major change in shoreline type. The extensive sandflats exposed at low spring tides (right, photograph B) carry low foredunes at their upper edge (photograph C taken near Central Gap at 3 looking south-east to the Foreland). The lower beach profile varies seasonally and may be radically changed overnight by storm conditions, often leaving heavy driftlines of marine algae, and *Zostera* species.

South of the main car park, where a low wooden wall protects eroding dunes and low shale cliffs, the narrow sand beach (4, photograph D below) is replaced at Redend Point (5, photograph E below) by a wave-cut rock platform strewn with large boulders. Around Redend Point, an iron-stained quartz sandstone cliff, are several ironstone boulders and stacks. To the south the sandy beach is replaced seawards by shingle and boulders (photograph F, below). Here a wall of wooden planks marks the toe of a thinly wooded slope with beach huts at the base. Southwards to the angle of the bay (6) recent mudflows in the clay cliffs provide a gentle slope with several large trees having recently slipped to the top of the sandy beach (photograph G, below right). From this point eastwards the scrub-covered clay of the Reading beds ascends from beach level to the top of the chalk. Below the cliff and extending to the Foreland is a wide shelf of chalk, partly covered in sand and strewn with flints and boulders, the lower ones with growths of brown seaweeds (photograph H, below right, taken at 7 looking towards the Foreland).



A

B

C

D

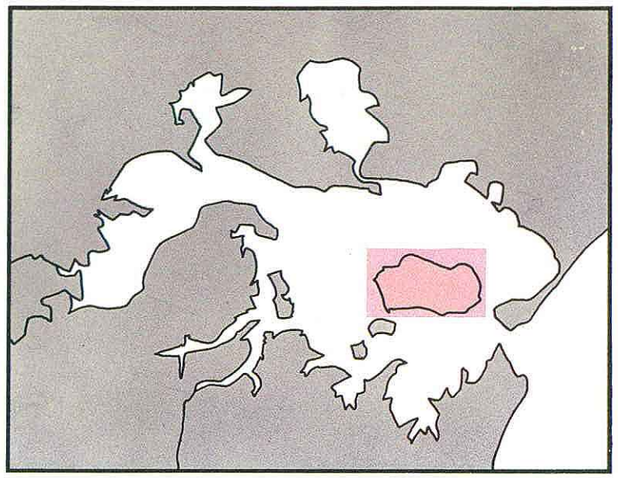
E

F

G

H

13. Brownsea



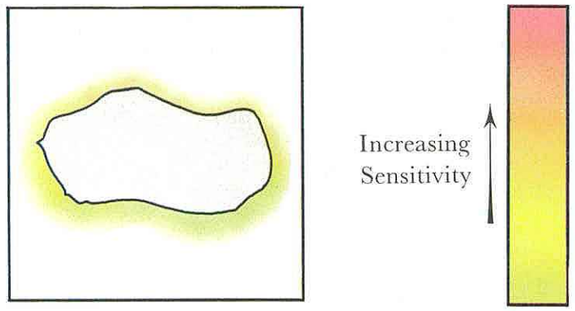
Brownsea Island, with an area of around 200 hectares (c. 500 acres) is the largest island in the Harbour and its Bagshot sands and clays are extensively capped with Pleistocene Plateau Gravel. The island's shorelines are largely narrow beaches of sand and shingle and are being extensively eroded. They also contain many fragments of pottery, largely pipeware, originating as waste from the former pottery industry. Based at the western end of the Island the pottery was active in the latter part of the last century and, at one time, employed a workforce of 300 men. The Island is owned by the National Trust and receives many summer visitors.

Historically, the sand and gravel eroded from the cliffs has been carried eastwards along both the northern and southern shores.

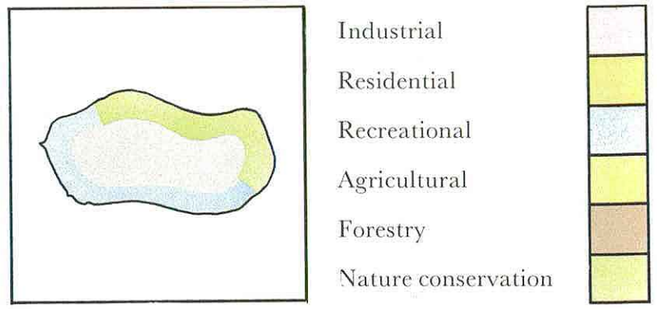
The northward curving of the southern beach to meet a spit developed along the northern edge (and produce the former St. Andrew's Bay) provided the base for the sea wall which now encloses a large brackish-water lagoon in the northeast corner. The legacy of an attempted agricultural reclamation in the 1850s, this lagoon is fringed in the west by marshland. Small areas of salt marsh and shingle vegetation are associated with eastward projecting spits along the north shore.

The bird populations of Brownsea are centred on the lagoon (which is part of the Dorset Naturalists' Trust Nature Reserve). It is used as a high-tide roost by waders, a daytime refuge for ducks, a nesting area for several species, including common and sandwich terns, and is regularly visited by a number of rare winter visitors, notably in recent years the avocet. The Brownsea heronry with around 100 breeding pairs is one of the largest in Britain. However, comparatively few of the birds, for which Brownsea is justly celebrated, actually feed or roost within the inter-tidal area. Water-borne oil is therefore likely to have a less damaging effect on the beaches than might be suggested by the numbers of birds counted around the Island.

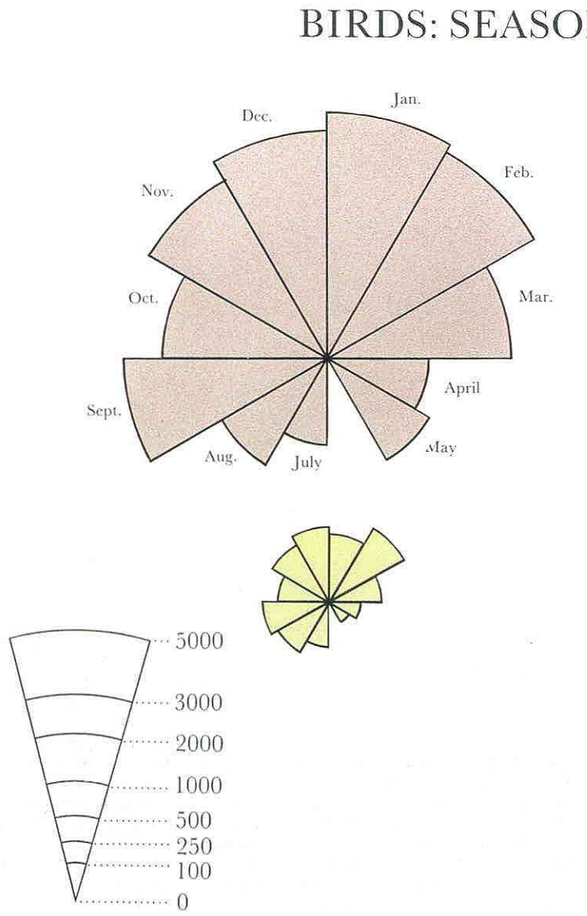
ECOLOGICAL SENSITIVITY



LAND USE



BIRDS: SEASONAL VARIATION



INTERTIDAL

The lagoon is used as a high water roost by substantial populations of several wader species. Perhaps most notable is the black-tailed godwit, the average high count of 388 being more than 70% of the Poole Harbour total of this conservationally important species. The numbers of the related bar-tailed godwit (100), which feeds mainly along the Sandbanks shore to the north (map 1), are around 60% of the Harbour total, as are those of grey plover (91), spotted redshank (24), knot (27) and oystercatcher (600) – this last species also breeds in small numbers around the lagoon and Island. Other waders are found in proportionally high numbers with around 30% of the Harbour's ringed plover, redshank, greenshank and curlew sandpiper, and around 15% of the curlew, dunlin and turnstone likely to occur. Avocets have become regular visitors in recent years and several other rare waders and waterfowl have been observed (see Bromby in Prendergast & Boys 1983).

At more than 450, the average high count of shelduck is around 18% of the Harbour total.

GULLS

Although more than half the harbour total of greater black-backed gull may occur (an average count of 33) the numbers of gulls are relatively low. Around 200 pairs of black-headed gull nested around the lagoon in 1980; nesting among them were common tern, which, with sandwich tern, have become established breeders in recent years.

The lagoon, with nearby freshwater lakes, provides a daytime refuge for ducks. – Teal (572≡40% of Harbour total), wigeon (217≡13%), shoveler (109≡71%) and pintail (106≡26%) are the most numerous. Gadwall (10≡33%) are rarer, but significant in number.

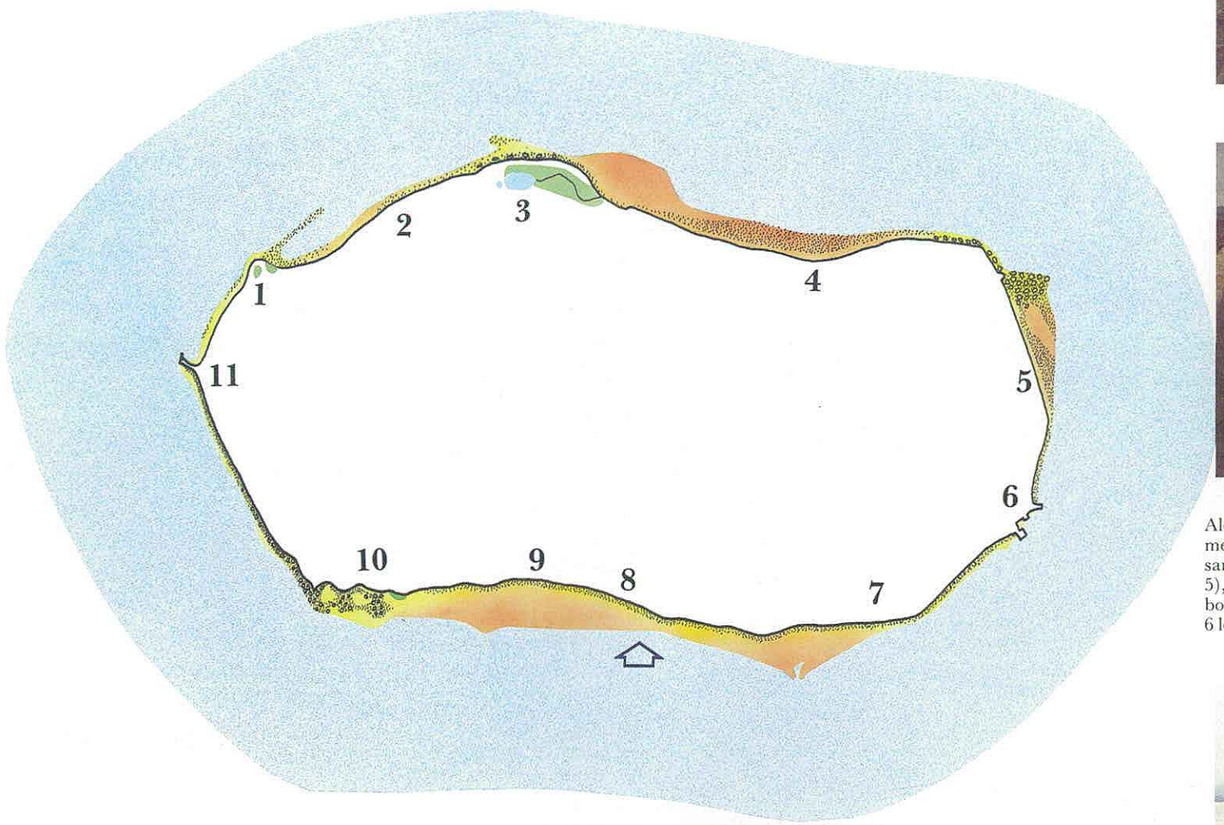
High numbers of cormorant occur off the north shore of the Island, the average high count of 86 representing 46% of the Harbour total.

Brownsea Island is also well known for its heronry. Nesting in the tall Scots pines are an average of more than 100 pairs. Other breeding species include woodcock and water rail.

13. Brownsea

In the northwest corner at Maryland (1) a sand spit topped with shingle (top left) curves northeastwards enclosing a small area of salt marsh in which *Juncus maritimus* has been partly buried by sand. To the east the wooded slope backing this marsh descends to the shoreline and below Wellington Hill (2) several pine and birch trees and rhododendron bushes have fallen onto the top of an eroding sandy beach. At Seymers Marsh (3) is another marsh complex associated with an eastward-projecting ridge of shingle, carrying *Suaeda vera*, and, on sand, *Ammophila arenaria*. Drained by a stream running eastwards the marsh, with *Puccinellia maritima* and *Juncus maritimus*, fringes a small lagoon.

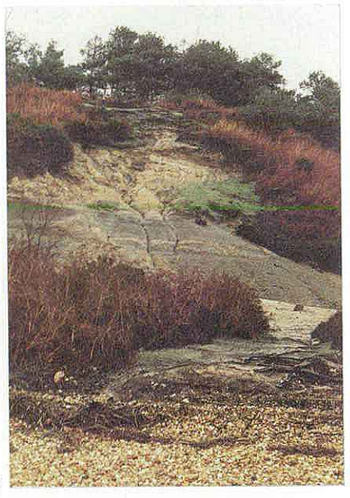
A narrow sandy beach, with shingle and shingle-covered muddy sands to seaward, runs eastward below a wooded slope to the concrete wall at the west end of the Brownsea Lagoon (4, and right). The sand beach seaward of the lagoon wall is strewn with large *Fucus*-covered boulders increasing in number towards the northeast corner.



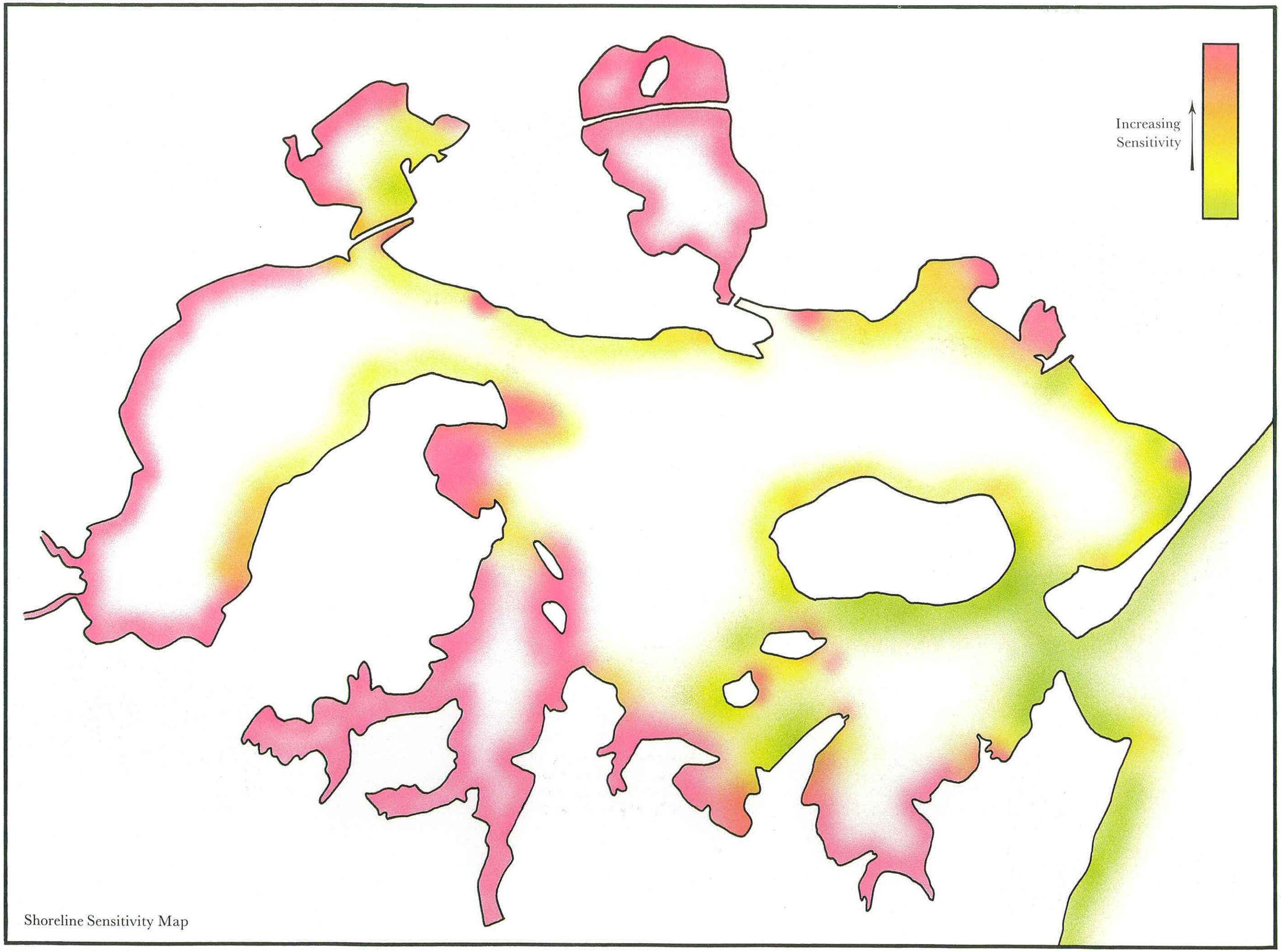
Boulders
Shingle
Sand
Muddy sand
Sandy mud
Mud
Spartina Marsh
Upper Salt Marsh
Reeds

0 100 500 1000
metres

Along the east shore, below the lagoon barrier of concrete and metal pilings, a beach of sand and shingle descends to muddy sand with gravel spurs in the north (above, looking north from 5), and to shingle-covered muddy sand with many scattered boulders in the south (below, taken between the two piers at 6 looking southwest).



A narrow sand and shingle beach crossed by several small groynes runs southwest to Portland Hill (7). The beach skirting the south shore is predominantly shingle-covered at the top with sand to seaward. In some areas it is formed on clay and in others large rocks are scattered at the base of the cliff. West of Portland Hill the cliff at the top of the beach is largely vegetated, with pine, gorse, bracken and rhododendron, but in places the sandstones and clay are exposed along eroding cliff faces (near left at 8). Below St. Mark's Lodge (9) the toe of the eroding cliff is currently being protected by a wooden palisade (centre left). West of an area of eroded salt marsh the upper shore and promontories are covered with broken pottery (10, and far left) and the beach running northwest to Pottery Pier (11, and far left above) consists almost entirely of pottery with some shingle and boulders. It is backed by low cliffs of earth and pottery, rising towards the pier and protected along one stretch by iron pilings.



Shoreline Sensitivity Map

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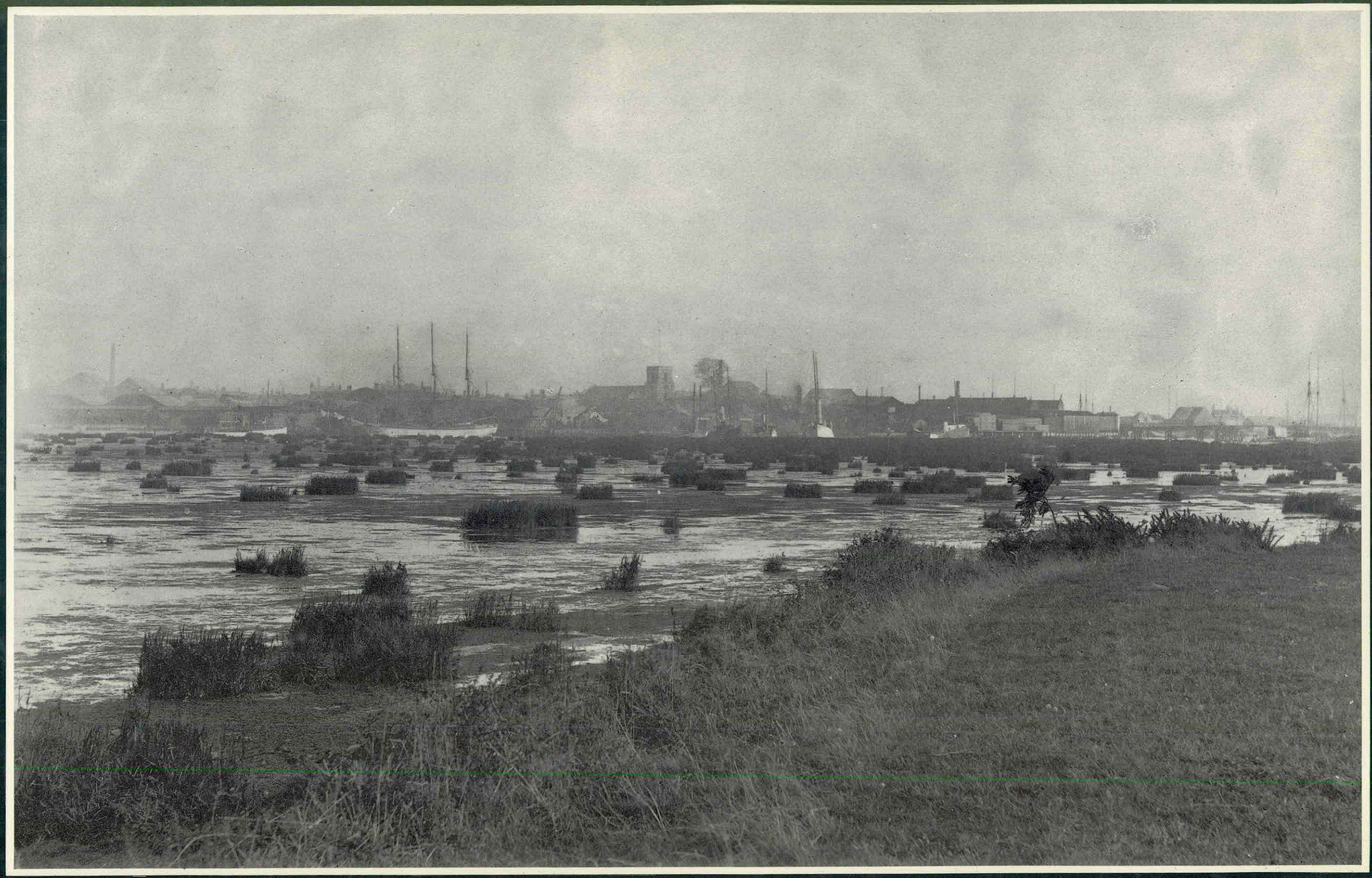
Back cover: Holes Bay, Poole Harbour, in 1913 showing invasion of *Spartina*.



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