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SURVEYS OF HARBOURS, RIAS AND ESTUARIES IN SOUTHERN BRITAIN

CHRISTCHURCH HARBOUR

Volume 1 - Report

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CHRISTCHURCH HARBOUR

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SURVEYS OF HARBOURS, RIAS AND ESTUARIES IN SOUTHERN BRITAIN

PREFACE TO REPORTS

The marine inlets of southern Britain are almost all formed from drowned valleys. They vary in shape, size, depth and salinity according to their historic and present hydrographic influences. All are more-or-less sheltered from wave action and have therefore been the focus of many urban and port developments. Some support or have supported important fisheries and several are currently being developed for shellfish and fin fish farming. Many of these inlets are known to include marine or estuarine habitats and communities which are rarely encountered in the British Isles. Some are already known as rich areas for marine life. However, little is known of the ecosystems present within many of these areas and new and potential developments make description and comparison urgent if scientific interests are to be taken into account during planning. Therefore the Nature Conservancy Council has commissioned the Field Studies Council to undertake studies of the area over an initial three year period from 1985 to 1988.

There are 24 inlets included in the study. Some are already well documented and may need little survey work. Others require a considerable amount of field work and analysis of data.

Our work consists of both a review of available information and field work.

The aims of the information review are:

1. To describe the areas in terms of their physical attributes.

2. To review the results of previous marine biological and related studies both published and unpublished.

3. To review fisheries, boating activities, port operations, diving activities, educational activities, research studies and other marine resource usage.

4. To catalogue available information.

Items of published and unpublished information are entered onto computer files and can be retrieved by area or subject. A paper copy of each entry is maintained in a loose-leaf file ordered by area.

Where field work is carried out, it aims to:

1. Collect information on the habitats present and the abundance of species in those habitats at sites selected to include a wide range of different shore and seabed types, areas of known conservation importance, or where rare species are or might be present.

2. Collect photographs of the habitats, communities and species present.

For each area where surveys are undertaken, the following reports are produced:

Volume 1 - Report of field surveys
Volume 2 - Species distribution records
Volume 3 - Field data
Volume 4 - Catalogue of photographs

Keith Hiscock
October 1985

SURVEYS OF HARBOURS, RIAS AND ESTUARIES
IN SOUTHERN BRITAIN

CHRISTCHURCH HARBOUR
SYNOPSIS

Christchurch Harbour is situated in east Dorset, approximately mid-way between Poole harbour and the Solent. It was formed during the post glacial marine transgression which drowned the combined lower river valley of the Rivers Avon and Stour. It has a length of approximately 2.5 km and an area of not more than 2 km^2. The harbour consists mainly of intertidal fine muddy sand, with small areas of salt marsh around its southern, western and north western shores. The combined river flow of the Avon and Stour occupies a shallow low tide channel cutting through the sediment flats, but is deflected northward through a very constricted entrance, The Run, before reaching the sea. This deflection, and occlusion of the harbour entrance, is caused by a double spit feature resulting from coastal erosion and longshore drift. With high river flow rates, especially in winter, fresh water can become ponded within the harbour, restricting saline inputs from the sea at the same time. Consequently, most of the harbour is brackish but the degree of salinity reduction varies with tide and the season.

The harbour is attractive scenically, with no industrialised hinterland, and is an important centre on the south coast for recreational water sports. There is little commercial fishing within the estuary apart form netting for salmon, sea trout and eels. The River Avon in particular is noted both for its salmon run and for its coarse fishing. The area receives a lot of visitors, especially holiday makers from nearby Bournemouth and Southbourne, and attractions such as Hengistbury Head to the south of the harbour are under considerable pressure. The harbour is also of ornithological interest, because migrant birds crossing the Channel appear to favour the area as both a landfall and a dispersal point.

Stanpit Marsh is a Local Nature Reserve, and most of Christchurch Harbour has been notified as an SSSI. Scientific interest in the past has been centred on the region's geology and physiography, together with its diversity of botanically interesting maritime habitats.

The present survey, carried out in June 1987, aimed to collect information on the variety of habitats and communities present subtidally and intertidally in Christchurch Harbour. A total of 32 sites were visited, of which 23 were intertidal and 9 subtidal. At each intertidal site the abundance of flora, epifauna and conspicuous species was recorded in situ. Sediment cores were taken and sieved over a 0.5 mm mesh to obtain quantitative infaunal data. Subtidal areas were sampled using a combination of diving and dredging.

Within the harbour, habitat diversity was low and predominantly sedimentary in nature, or sediment-influenced. Epifaunal and algal diversity was also low due to the generally reduced salinity regime, and a lack of stable substrata. The most diverse fauna and flora found was on the isolated ironstone boulder outcrops outside the harbour. The macroinfauna was also of low diversity generally and was characterised by very dense populations of a

restricted number of species. Within the length of The Run, the fauna changed from a coastal type dominated by Lanice conchilega, to an upper estuarine or brackish type dominated by Streblospio shrubsolii, Corophium volutator and Hediste diversicolor. This fauna type extended across the main open part of the harbour as far west as Wick Hams, after which estuarine species dropped out to be replaced by fresh-water or brackish forms.

The scientific and nature conservation importance of the area has been assessed using standard criteria. These have been applied to each of the habitats or community types identified which have then been provisionally graded as being of Local, Regional, National or International importance. No species of particular scientific interest were found during this survey work, but the conservation importance of three invertebrate species recorded by other workers from brackish saltmarsh habitats has been assessed in a similar manner. These were two species of ostracods, Callistocythere murrayi Whittaker and Cytherois stephanidesi Klie, and an amphipod, Gammarus insensibilis Stock. Their gradings are provisional because these groups, and their habitats, have not received wide or intensive study and their distributions still require elucidation. Although the harbour has been assessed mainly as an estuary, it also possesses distinctly lagoonal properties, and the assessment of this interesting coastal inlet may require adjustment as the status of Britain's lagoonal habitats becomes better known.

1. INTRODUCTION AND HISTORICAL PERSPECTIVE

Christchurch Harbour (Grid Ref. SZ 7091) opens into the western side of Christchurch Bay which is situated midway along the south coast between Poole Bay and the Solent (Fig. 1, which folds out at the back of this report). It constitutes the estuary of the Rivers Avon and Stour which converge and enter the harbour at its northwestern end. The harbour is approximately 1.6 km^2 in area, is mostly intertidal and very shallow, and has a narrow indirect sea entrance through a double spit feature.

The main centre of population is the Borough of Christchurch (population more that 43,000) which nowadays is almost continuous with the Bournemouth and Southbourne conurbation to the west, and Highcliffe and Barton-on-Sea to the east. Christchurch itself is situated between the Rivers Avon and Stour at their confluence. It was a walled Saxon town, one of Alfred the Great's strongholds against the Danes, and was originally called Tweoxnean (and later, Twynham) meaning 'the place between the waters'. The town takes its present name from the priory church which dates from early Norman times, and which dominates the town and countryside for miles around.

Almost continuous with Christchurch, and bordering most of the northern shore of the harbour to the coast, are the expanded and merged villages of Purwell, Somerford, Stanpit, and Mudeford which have a total population of approximately 14,000 people. These villages are largely residential although Mudeford, with its quay sited at the entrance to Christchurch Harbour, is the centre of a small local fishing industry.

South of Purwell, between Christchurch and Stanpit, an area of marshland called Stanpit Marsh (60 ha) projects into the harbour. Late Neolithic and early Bronze age remains have been excavated here, and it is also a Local Nature Reserve.

The western and southern sides of the harbour are formed by the peninsula which culminates in Hengistbury Head. This headland, which at 36m high is the most prominent land feature in the area, has revealed traces of Man's settlement there dating back to the Upper Palaeolithic. The site is of great historical importance and is a designated Ancient Monument. Evidence of the estuary having been used as a harbour goes as far back as the late Iron Age (100 B.C. - 43 A.D.), and it is known that the people of Hengistbury had contact with traders from the Mediterranean and from the continent. Following the Roman invasion in 43 A.D. and the destruction of Dorset's hillforts (such as the Double Dykes fort at Hengistbury), there was only a comparatively minor settlement here which had an economy based on farming and fishing. Since these times, the harbour has never succeeded as a major trading port and has been used mainly by local fishing vessels, small traders and smugglers. In recent years it has developed into an important centre for marine recreation.

Various proposals and attempts have been made to improve the estuary as a harbour since the 17th century. These were originally made with the intention of making the River Avon navigable as far as Salisbury and to establish Mudeford as a coastal port. Nearly all these schemes involved straightening the course of the Avon at its mouth by cutting through the base of the spit at Hengistbury. This was actually achieved in 1698 but the cutting was blocked again by a storm in 1730. The remains of an ironstone pier built as part of this project are still visible at low tide and are known today as Long Rocks or Clarendon's jetty.

Accounts exist of the harbour's saltmarshes being used for the production of salt during the 19th century, and Hengistbury Head was also the site of a lime-kiln. Another local resource, which has been exploited since at least the Iron Age, is the outcrop of ironstone at Hengistbury Head. As building material, it was used in the foundations of the Christchurch town walls in the 10th and 11th centuries, and also in the short-lived harbour improvement scheme of the 17th century. At that time there were proposals to use ironstone (which has an iron content of 30%) in the manufacture of cannon for use in the French wars. During the latter half of the 19th century, it was mined extensively for the first time, and large quantities of material were removed from the shoreline, the headland, and then from the ledge extending out to Beerpan rocks. It was used as profitable ballast for coal barges on their return journey to Wales. The effect of removing so much of this very resistant rock was to expose the hitherto protected softer sandstones of the headland to marine erosion processes.

This in turn led to a rapidly receding headland and a period of rapid spit growth around the corner at the entrance to Christchurch Harbour. Mining operations stopped in 1873, and the erosion problem at the headland and cliffs to the west was finally halted by the construction of a long groyne in 1938. This groyne at the tip of the headland, however, served to reduce the sediment supply to beaches to the east, and additional groynes have since been built along the spit to prevent its disappearance.

2. PHYSICAL CONDITIONS

2.1. Geology and topography

The south coast around Christchurch lies within the Hampshire Basin. This structure is underlain by Cretaceous chalk which, after being uplifted, eroded and gently warped, was overlain by Tertiary clay and sand deposits. These include the Bagshot, Bracklesham and Barton beds of the Eocene period, and Christchurch Harbour is founded on the upper Bracklesham beds (Fig. 2.). The region was then subject to further uplift, and was folded along the axis of the Purbeck - Isle of Wight anticline. Following erosion of the folded strata, Pleistocene deposits were superimposed, and their distribution is closely related to the present position of rivers and estuaries in the Hampshire Basin. During the Pleistocene glacial phases, river valleys were excavated to well below the present sea level and deposits of these periods consist of flints and gravels on old river valley floors and terraces. Mud and beach deposits were laid down during interglacial periods. During glaciation, the present rivers and estuaries were tributaries of the 'Solent River' which flowed eastwards across what is now Poole Harbour and Christchurch Bay, along the present course of the Solent, and joined the English Channel somewhere south of Sussex. As a result of the marine transgression following the last glaciation, the Purbeck - Isle of Wight chalk ridge on the southern edge of the Hampshire Basin was breached, and the soft Tertiary beds behind were exposed to marine erosion processes. Since then, the River Avon has flowed directly into the sea.

Therefore the surface geology of the area consists of soft and easily eroded Eocene sedimentary strata, giving rise to a low-lying landscape.

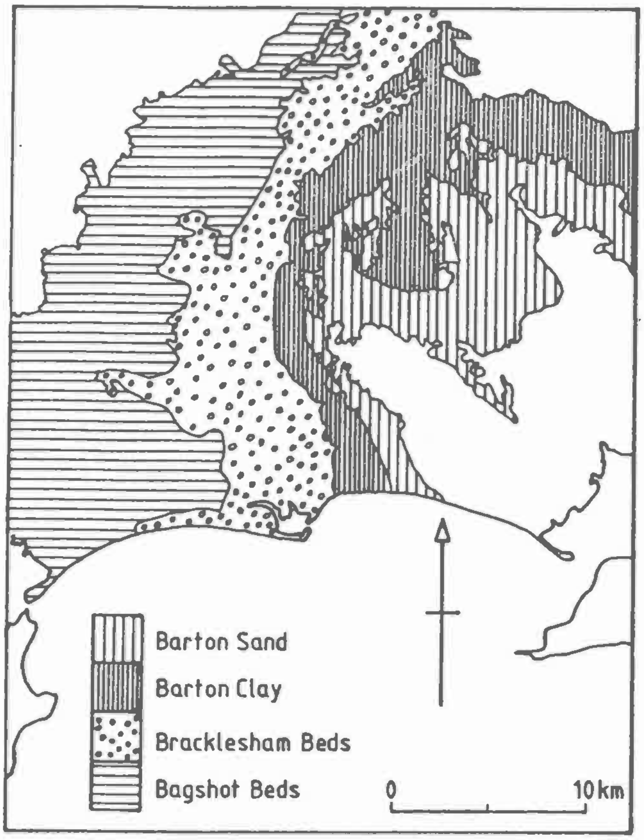


Fig. 2. The solid geology of the Christchurch region.

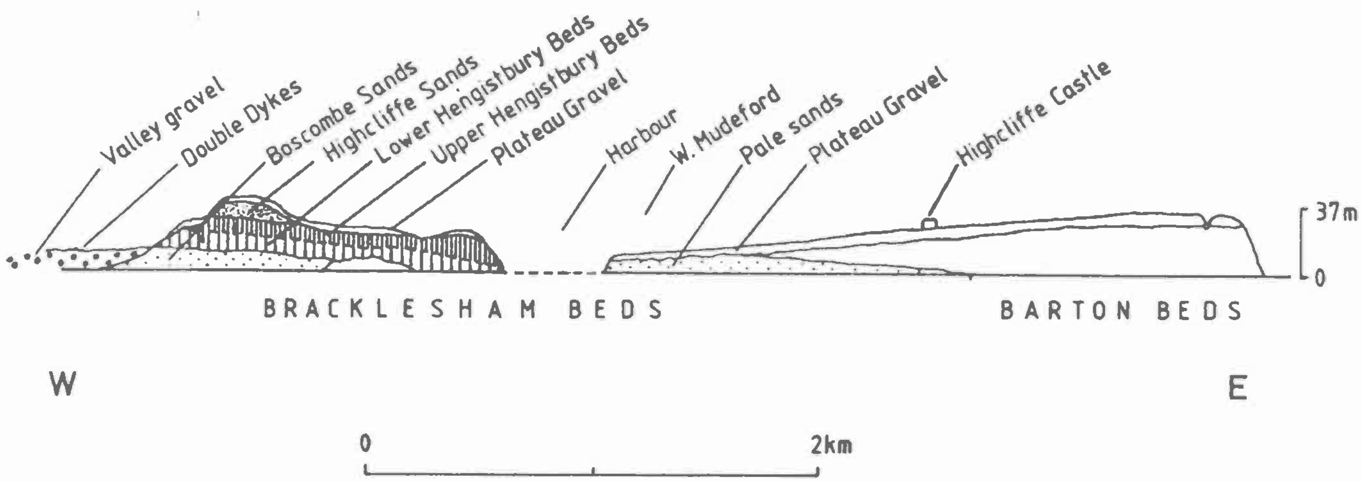


Fig. 3. Sketch section of the Bracklesham Bed Sequence.

The harbour is cut into the Boscombe sands of the Upper Bracklesham beds. To the west of the harbour, at the neck of the Hengistbury peninsula, these sands are overlain by valley gravels which are thought to represent the river bed of a north-flowing tributary of the old Solent River. More recent deposits in the Bracklesham beds sequence are exposed in the high ground at Hengistbury Head (36m high) and also to the east of Mudeford where the ground rises again to form low coastal cliffs beyond Highcliffe (Fig. 3.).

Nodules of ironstone occur in the Upper Hengistbury beds which constitute the hardest and most resistant part of the deposits to marine erosion. Remnants of the ironstones and the former coastline form the Beerpan rocks and Christchurch Ledge to the south and east of the headland.

2.2. Hydrography

2.2.1. Bathymetry and tidal heights The bathymetric features of Christchurch Harbour are shown in Fig. 4. From the Avon and Stour confluence, the main channel winds through the confined space between Stanpit/Grimbury Marsh and Wick Hams Marsh for approximately 1 km before reaching the main open body of the estuary. The channel continues in a more or less easterly direction until it reaches the spit where it is directed northwards and out of the harbour via the constricted exit off Mudeford Quay.

The main low tide channel is very narrow (100 m at its widest point) and is also shallow, with depths generally not exceeding 1.0 m below chart datum (BCD). At either end of this channel, up near the confluence of the Avon and

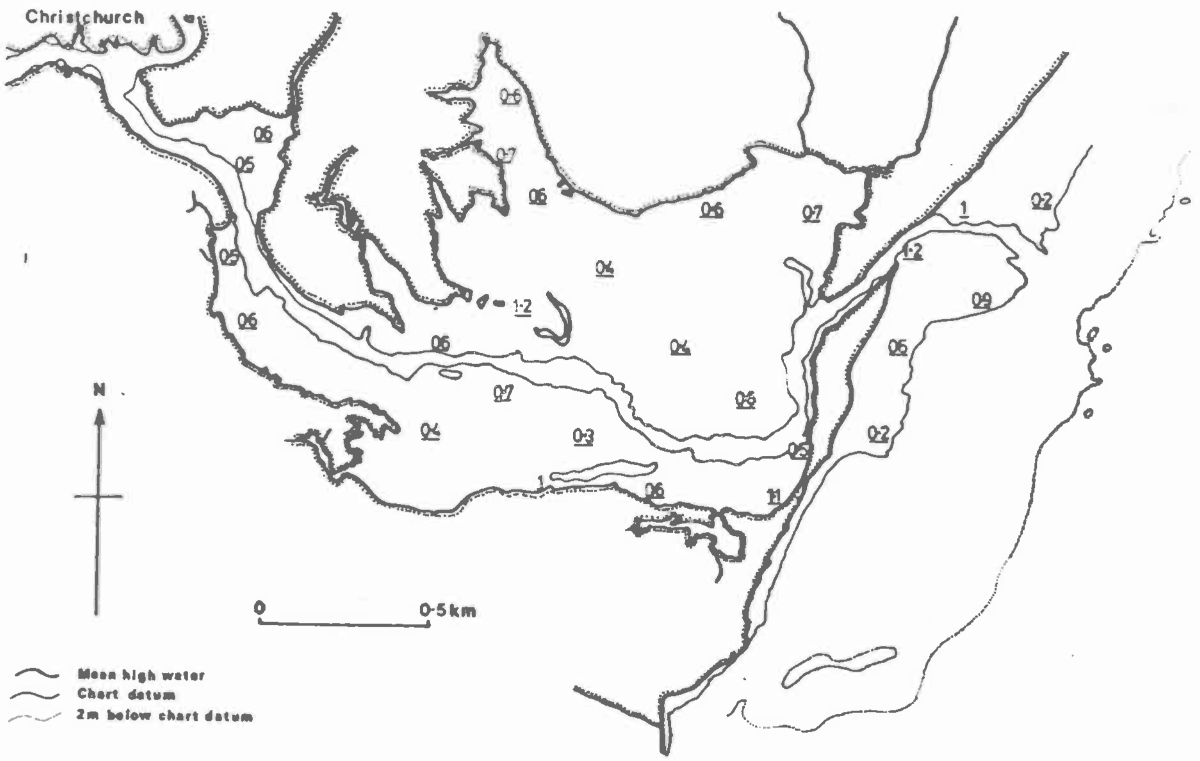


Fig. 4. Bathymetry and tidal heights in Christchurch Harbour.

the Stour off Stanpit Marsh and in The Run off Mudeford Quay, two or three small pits of 1-5 m BCD occur. Dredging is undertaken periodically and the resultant spoil has been used, on occasion, to maintain the spit at Hengistbury. Outside the entrance, Christchurch Bay is also very shallow, with the 5 m isobath occurring almost 1 km offshore.

Inside the harbour, the channel runs between extensive intertidal sediment flats which vary gradually in height from chart datum level up to approximately 1.0 m. On the edge of the channel, 250 m downstream from Stanpit Marsh, there is a low crescent-shaped island known as Blackberry Point which is never covered by the tides.

The mean tidal range in the harbour is 1.4 m for spring tides and 0.8 m for neaps. The tidal regime here is complicated by the proximity of the Solent system. The effects of this are variable, but at high water springs a double high tide occurs and at high water neaps effects range from a short stand to no effect at all. Tidal predictions are also complicated by the relatively large river flow into the harbour, especially during the winter. The normal tidal limit extends up both rivers as far as the Iford bridge on the Stour, and to just beyond Purwell on the Avon.

2.2.2. Temperature. Few published data exist for Christchurch Harbour. Murray (1966) recorded an annual temperature range at the seabed of 4.2°C to 20°C (January to August) but added the proviso that lower minimum temperatures probably occurred at night. With its extensive shallows, temperatures are bound to follow diurnal and seasonal air temperatures more closely than offshore marine habitats. Murray also noted that the harbour is also liable to partial freezing during very cold winters. Surface water temperatures in 1976 ranged between 2°C and 25°C, with mean monthly values ranging between 4.5°C in January and 20°C in July (Marine Training Centre data, Pearce and Bate, 1980).

By comparison, the seabed temperatures outside the harbour in Christchurch Bay and the English Channel have a much narrower range, varying from 7°C in February to 19°C in August (Crisp and Southward 1958; Holme 1961).

2.2.3. Freshwater input and salinity. The catchment of Christchurch Harbour extends beyond the Vale of Pewsey to the north where the Avon rises, and as far west as the North Dorset Downs where the Stour rises. This represents an area of approximately 2600 km^2 (Fig. 5). Over this area the average annual rainfall ranges between 750 mm and 1000 mm, and over Christchurch Harbour it is approximately 850 mm (Bickmore and Shaw 1963). Almost all of the drainage from this catchment enters the estuary via the Avon and Stour rivers. The River Avon (the larger of the two) has a flow rate ranging between 4-10 cumecs during the summer and 38-53 cumecs over the winter (West Hampshire Water Company, unpublished data). No data have been seen for the River Stour, although national river flow maps prepared by the National Water Council (1980) indicate an annual average flow rate of between 10 and 40 cumecs. A much smaller river, the River Mude, discharges directly into the northern side of the harbour at Mudeford.

Salinity data are given in Murray (1966) and are also available at the Marine Training Centre at Wick Hams (Hawes, 1982, unpublished data). Due to large riverine inputs, the small size of the estuary, its shallow depth and the restricted sea entrance, salinity is reduced over the whole area relative to outside seawater. This is especially so at low water when sea water penetration against the river flow is minimal. During the winter months when

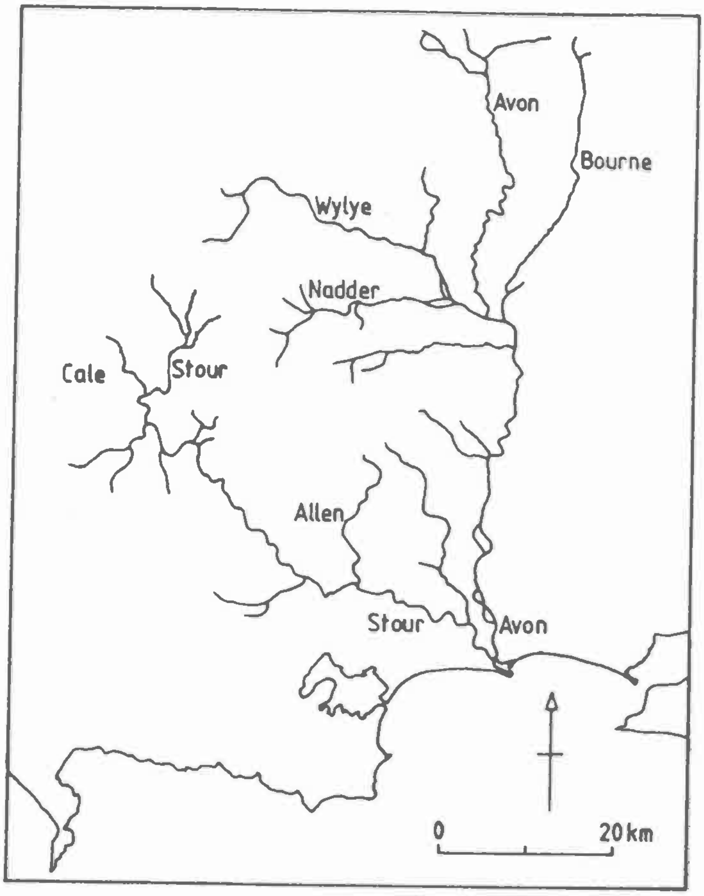


Fig. 5. The Christchurch Harbour catchment.

riverine inputs are highest, Murray (1966) found that at high tide the whole southern half of the harbour was virtually fresh (< 2 ^{o}/oo), although in the northern half (off Stanpit shore) readings at the seabed of up to 28.9 /^{o}oo were obtained. Thus even at high water, marine saline inputs can be restricted to a relatively small flow through The Run and up around the northern edge of the harbour. However, as river flows are reduced through the spring, summer and early autumn, a salt wedge stratification develops which, in 1960, was detected by Murray as far upstream as the lower reaches of the Avon and Stour. In the main body of the harbour at this time, recorded seabed salinities were all greater than 30 ^{o}/oo, though reduced in comparison to full seawater (34-35 ^{o}/oo). In terms of estuarine classification (Dyer, 1979), Christchurch Harbour probable varies between a salt-wedge type in the summer (calm lagoonal conditions with river exit to the sea occluded and minimal river discharge) and a partially-mixed type at other times of the year.

2.2.4. Tidal streams. Data have been obtained from the Channel Pilot (1977 edition with 1982 amendments) and Murray (1966).

In The Run, tidal streams flood and ebb at an average rate of 3-5 knots. These rates are highest during spring tides and are further increased during periods of high river flow. Furthermore, ebb flows are faster than the flood due to the double high water or high water stand feature which cuts the ebb period to 3 hours compared to a flood period of up to 7 hours. Currents of 9 knots have been recorded in The Run. Within the harbour, currents tend to be fastest around low water when tidal flow is restricted to the main channel. At other times, water flow is dissipated over the wider area of the estuary's sediment flats.

2.2.5. Exposure to wave action. Holme and Bishop (1980) classified the whole of the shoreline within Christchurch Harbour as Very Sheltered. This was due to the shelter provided by the spit across the harbour mouth which reduces the effective wind fetch. The open sea coast, facing almost due east, was classified as Moderately Exposed because although it is sheltered to a large degree from the prevailing south westerly wind and waves, strong south or south easterly winds are occasionally received. These are strong enough to push sea water and sediments over the spit and have, on occasion, completely breached the structure.

The National Maritime Institute have installed a wave research structure in Christchurch Bay 4 miles east of Hengistbury Head. This provides long term data on waves, tidal currents and scour for this section of the coast which is subject to continuing marine erosion.

2.3. Substratum types.

The predominant substrata throughout Christchurch Harbour are sedimentary, ranging from silty fine sands in the more sheltered areas, to pebbles and cobbles on the areas exposed to strong tidal currents (Fig. 6.). The occurrence of stable hard substrata is limited to the metal and concrete-faced quayside at Mudeford, and the concrete walls and slipways which line much of the upper shore along the northern side of the harbour. Otherwise there are the occasional jetty and beacon pilings of metal or concrete dotted around the harbour.

Sediments are brought into the harbour by the rivers and by the sea. The sands and shell gravels imported on the flood tides are deposited as sandbanks just to the west of The Run where the harbour widens out and the currents slacken. Material is also derived from the sea coast by wind and wave transport over the spit. Dredge spoil from the harbour has been used to maintain this coastal feature in addition to the construction of groynes on the seaward side.

The composition and distribution of sediment types across the harbour bed was the subject of a study by May (1984, unpublished data). In general, sediments are dominated by fine or medium sand fractions and show a tendency to coarsen upstream between the flood-tide delta at the entrance and the constriction between Wick Hams and Grimbury Marsh. This pattern is particularly clear on the south side of the harbour and in association with the main channel. The mean particle size also tends to increase up the main embayments before decreasing shorewards. Mud (the clay and silt fractions combined) dominates the sediments in and around the salt marshes and in the main embayments at the four corners of the roughly square outline of the main open harbour. The more sheltered and muddy sediments are usually the most reduced, or hypoxic, with the blackened coloration approaching to within 2 cm of the surface. Elsewhere the black layer occurs at depths of up to 20 cm or more.

Outside the harbour on the open coast, there is an outcrop of ironstone boulders on the shore at Hengistbury Head which together with the groynes constitute stable hard substrata. Offshore, a subtidal ironstone boulder reef extends 5 km to the southwest of Hengistbury Head.

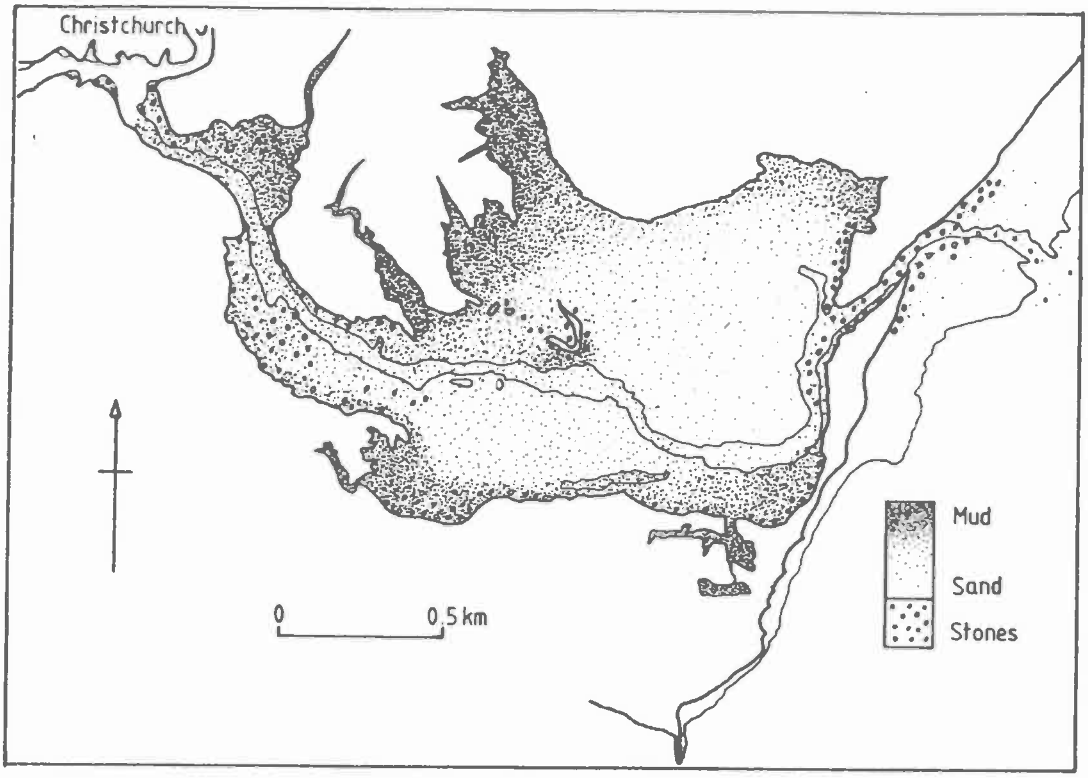


Fig. 6. Substratum types in Christchurch Harbour.

3. HUMAN INFLUENCES

3.1. Sewerage and storm drains.

The catchments of the Rivers Avon and Stour are mainly agricultural and rural in nature, apart from Salisbury, Christchurch and the northern edge of Bournemouth. Sewage effluent from the Christchurch area is discharged into the Avon following an activated sludge treatment process. The sludge is then disposed of to the land after digestion. Other than inputs received via the rivers, there are no major effluent discharges into Christchurch Harbour itself. Minor inputs to the harbour occur from some public conveniences, and can also arise from sewerage system overflow points during periods of high rainfall or breakdowns at the pumping stations.

Another source of crude sewage, identified as being potentially significant in the Christchurch Harbour Recreation and Conservation Plan, is from moored boats. This would only pose a problem, presumably, if these boats were lived in for much of the year. River and estuarine quality is dependent on many factors, but in 1980 the whole of the Avon system was graded as 1A, good quality (National Water Council, 1980). In the same report most of the Stour system was graded as 1B, good quality, although the section below Holdenhurst was rated 2, fair quality. The tidal reaches of the Stour, as part of the estuary, were also slightly below par at B, fair quality, while the estuarial quality of the remainder of Christchurch Harbour was graded as A.

3.2. Industrial effluents and pollution.

There are no industrial activities discharging aqueous effluents into the harbour or into its catchment area.

In the past few years there has been concern about the environmental effects of organotin antifouling paints in sheltered coastal waters used by yachts and small craft. The main concern, and research effort, has been directed towards shellfish and the shellfish industry which are particularly vulnerable to very low concentrations of tributyltin species. This environmental problem has been reviewed in a report to the Marine Conservation Society (Wood, 1986). Although there is no shellfish industry in Christchurch Harbour, other research has given an indication of the wider marine biological effects of tributyltin pollution (e.g. Thain 1983, Loughlin et al. 1984, Bryan et al., 1986). No investigations of tributyltin levels have been carried out in Christchurch Harbour, which has a high population of yachts, motor cruisers and other small craft. Also, there is no background of scientific survey or marine monitoring against which to assess any pollutant effects. Therefore, following the government ban (from July 1987) on the retail sale of these paints and their use on boats less than 25 m in length, it is likely that any environmental accumulation or adverse effects on the benthos (and local fisheries) will pass unnoticed due to the effects of dilution, dispersion and degradation.

3.3. Port/harbour facilities and users.

Most of the harbour bed, including associated fishing and mooring rights, is owned by the West Hampshire Water Company. The mooring and fishing rights are leased to Christchurch Sailing Club, Christchurch Angling Club and certain individuals who sub-let them. The harbour bed east of the National Grid line Easting 418 is owned by the Meyrick estate and leased to Christchurch Council together with fishing and mooring rights. Buoyage in the harbour is controlled by the Christchurch Harbour Association.

Christchurch Harbour is mostly intertidal and is only suitable for small craft of up to 25 m length and 1.8 m draught. The main use of the waterways is in tourism and recreation of which dinghy sailing and fishing are the chief activities. The shallow water body restricts most craft to the main channel, although the unusual tidal cycle giving up to four high water periods a day extends the period for which most of the harbour can be used by dinghies, canoes and windsurfers. There are approximately 1000 moorings in the harbour which is close to the maximum number (1,150) considered desirable in the Christchurch Harbour Recreation and Conservation plan (Hampshire County Council, 1968). These nearly all dry at low water, and are controlled mostly by Christchurch Council, Christchurch Sailing Club and Christchurch Angling Club. Further development of moorings along the shoreline would impede navigation and shore-based activities such as angling.

There are at least four sailing clubs in the area based in Christchurch, Mudeford, and at the Marine Training Centre at Wick Hams. Because of the degree of shelter within the harbour, it is an ideal environment for teaching young people to sail, canoe and windsurf. There is also a competitive rowing club in Christchurch on the River Stour.

In connection with those activities, a number of boatyards and marine specialists exist in Christchurch and around the north harbour shore with facilities for boat building, repair and storage.

The harbour, including both the sea coast outside and lower stretches of the Avon and Stour, is noted nationally for its salmon fishing, coarse fishing and beach fishing. Species commonly caught include salmon, sea trout, bass, pollack, mullet, whiting, plaice, flounder, dab, sandeels, eels, roach, dace, barbel, bleak, perch and bream. The predominant quarry of the sea fishermen are bass and mullet which shoal during the spring and summer and migrate upstream; sometimes beyond the normal tidal limit. The opinion amongst local anglers is that the harbour forms a nursery ground for many of the above species, especially bass, mullet, pollack and flatfish of which very small specimens are often seen.

One consequence of the popularity of angling is bait digging on the intertidal mud and sand flats. Evidence of bait digging was seen at most access points around the harbour during the present survey. The species most commonly present, and therefore presumably used, are lugworm (*Arenicola marina*) and ragworm (*Hediste diversicolor*).

Other leisure activities taking place include wildfowling and, on the seaward sand beaches, bathing and picnicking.

3.4. Commercial utilization of fish stocks and mariculture.

Christchurch Harbour is a fishery harbour within the meaning of the Sea Fishery Industry Act, 1951. Most commercial fishing occurs outside the harbour along the coast, and a fleet of up to 33 small fishing boats (full-time, seasonal and casual) operate from Mudeford Quay looking mainly for lobster, crab, bass, sole, mullet and other demersal species (Major A. J. Parker, pers. comm.). Within the harbour, on ground leased by the Council, there is a small fishery for eels, mullet and bass. Landings are small, with an estimated average annual value of £237,120.

The Wessex Water Authority administer the fishery for migratory species (salmon, sea trout, and eels). Six licensed netsmen currently work the harbour for salmon and sea trout under the terms of the net limitation order. In 1986 the Wessex Water Authority initiated a 5 year research programme investigating the upstream migration of salmonids which have been caught, radio tagged and returned to the water at Mudeford. The aim of this study is to investigate the relationship between salmon movement and environmental conditions (river flow, water temperature, turbidity and various chemical variables) in order to help towards providing a sound basis for water resource management.

3.5. Educational. The value of Christchurch Harbour and its environs as an educational resource has been pointed out in previous planning documents and conservation assessments (Hampshire County Council, 1968, and Wise, 1975). The subject matter available for educational purposes covers geology, geography, history and natural history, and much information is already available in the form of interpretive booklets and leaflets, and nature trails. A complete environmental education pack, containing much locally derived material on all these subjects, has been compiled by the Marine Training Centre (Pearce and Bates, 1980). Much of the local education in these subjects is provided through the Marine Training Centre which also has facilities for the teaching of outward bound skills such as canoeing and sailing.

Locally inspired research, occasionally on a long term monitoring basis, has also been carried out under the auspices of the Christchurch Harbour Ornithological Group and the Friends of Stanpit Marsh.

There is a summer warden on the Stanpit Marsh Local Nature Reserve, and the management committee has, in addition, produced a series of reserve guide leaflets for visitors.

The only problems with such an easily accessible coastline are associated with disturbance and trampling pressures. Nearly 2 million people visit Hengistbury Head and the nearby area each year. A high degree of management is required in order to prevent, for example, the disappearance of breeding bird populations or the trampling of vegetation which can lead to erosion. Salt marsh erosion by the wash of power boats has been a problem, and strict speed limits are set within the harbour.

3.6. Established nature conservation importance.

The whole of the harbour, between the confluence of the Avon and Stour and the beginning of The Run, is included within the Christchurch Harbour Site of Special Scientific Interest (SSSI). This site was first designated in 1964 under the National Parks and Access to the Countryside Act of 1949, and included Solent Meads and Hengistbury Head. The site schedule was revised in 1977 and then renotified in 1986 under the Wildlife and Countryside Act of 1981. At this point the site was extended to include Stanpit Marsh which had been a Local Nature Reserve since 1964.

Points of interest specified in the SSSI notification include the geology and stratigraphy of Hengistbury Head which has aided the understanding of coastal and offshore Tertiary formations over the wider area of Poole and Christchurch Bays. Of ecological interest is the variety of maritime habitats present including saltmarsh, wet meadows, dry grassland, heath, scrub and sand dunes. These support plants, invertebrates and birds which are of interest either for their rarity or because of their local distribution. The harbour is an important landfall and dispersal point for bird migrants, and many unusual species have been recorded here. A wide variety of waders and wildfowl are regularly reported from the marshes and sediment flats, although numbers of almost all are small (Prater, 1981). The Mute swan regularly roosts here in nationally significant numbers. Comparatively little is known of the harbour's intertidal and subtidal habitats although a study of the Foraminiferida by Murray (1968) is mentioned in the citation.

Hengistbury Head is also of national archaeological importance, having yielded traces of Man's presence there from all periods between about 9000 BC and the Roman Age. Bronze Age barrows and an Iron Age earthworks, Double Dykes, have been excavated on this peninsula which is a scheduled Ancient Monument. Bronze Age traces have also been excavated at a site on Stanpit Marsh.

The L.N.R. at Stanpit Marsh is owned by Christchurch Council and managed by a committee drawn from interested groups such as the Nature Conservancy Council, Dorset Naturalists Trust, Christchurch Harbour Ornithological Group, and various other conservation, angling or wildfowling associations.

Many of the areas of biological conservation value in and around the harbour were identified and summarised by Wise (1975) of the Dorset Naturalists Trust, who also set out suggestions for their effective management in the future. These interests had previously been noted in a recreation and conservation plan for Christchurch Harbour published by the Hampshire County Council (1968). Although now out of date in certain respects, it was adopted by Christchurch Council following the 1974 government reorganization and remains in use until a statutory local plan for the area has been approved. In this policy Hengistbury Head is an Area of Great Landscape, Scientific or Historic Value and the whole of the headland and Solent Meads on the harbour's western shore is managed as a Public Open Space by the Public Parks Department of the Bournemouth Borough Council. On the northern shore, an area including Stanpit Marsh, Purwell, the Mudeford shoreline, Mudeford Quay and the top of the sand spit, is a proposed Green Belt zone.

4. PREVIOUS BIOLOGICAL STUDIES

Christchurch Harbour has received scant attention from marine biologists in the past and very little published material for the area exists in comparison to Poole Harbour and Poole Bay to the west and the Solent to the east. All of the marine biological literature seen (published and unpublished) is post-1960 and much of it is in the form of unpublished data collected by students at the Marine Training Centre. Abstracts of published and unpublished research are included in a separate Information Review file compiled as a part of this study, and are described below.

Faunal records in the estuary started in the early 1960's with a study of the benthic Foraminiferida by Murray (1961) as part of a Ph.D. thesis. This work included a taxonomic appraisal of the species present and also examined species distribution and abundance in relation to seasonal and environmental variation. Physical and chemical data were obtained which highlighted the unusual estuarine environment in the harbour (Murray 1966) and from which Murray deduced that biological activity (and foraminifera in particular) could be responsible for an observed calcium deficiency in the bottom water. In later papers, Murray (1968) and Howarth and Murray (1969) also divided the species into four groups on the basis of preferences in salinity and temperature as follows:

Group 1. Stenohaline marine. Forms typical of the open sea brought into the harbour in small numbers by tidal currents, and restricted to the estuary mouth.

Group 2. Slightly euryhaline. Forms able to tolerate small salinity variations (28.9-34.3 $^{o}/oo$). These are generally restricted to the lower estuary and main channel, but are able to colonise a wider area during the warmer summer months.

Group 3. Moderately euryhaline. Forms showing a similar environmental response to those in Group 2, but able to tolerate a wider salinity range (19.9-34.4 $^{o}/oo$) and with wider distributions.

Group 4. Truly euryhaline. The most abundant and widespread species showing independence from the measured environmental variables.

This work illustrates the extent to which the marine ecology of the harbour is influenced by the reduced and variable salinity regime.

Christchurch Harbour was also one of the study areas for another Ph.D. thesis (Whittaker, 1972) in which the taxonomy, ecology and distribution of marine and brackish water ostracods were investigated. This data was also presented in a later paper (Whittaker, 1981). In this paper, three distinct assemblages of benthic ostracods were recognised. Assemblage 1 typified the main open harbour area east of Wick Hams, and consisted of species tolerant of the wide salinity range 0 - 35 °/oo. Assemblage 2 was confined to the sandy substrata of the harbour entrance. This consisted mainly of species belonging to the first assemblage, but also included one marine form, Leptocythere macallana. Assemblage 3 typified the constricted channel and creeks west of Wick Hams, and included three species of particular interest. Cytherois stephanidesi Klie and Callistocythere murrayi Whittaker were both new records for Britain, the latter being originally described from its type locality in Mother Siller's Channel (Whittaker 1978). Both species have since been recorded rarely at similar habitats elsewhere, namely Pembrokeshire, East Anglia and the Arcachon Basin (C. murrayi) and the English south coast (C. stephanidesi) (Whittaker, pers. comm.). Leptocythere ilyophila (Hirschmann) was also thought to be present, but turned out to be a widely recorded relation, L. porcellanea (Brady). The rarity of species in groups such as the Ostracoda is often due more to under-recording or taxonomic confusion than to an actual restricted distribution.

Other aspects of the benthic fauna have received study from the students attending the Marine Training Centre and from the summer wardens on Stanpit Marsh Local Nature Reserve. Loakes (1977), Campbell (1984), Walls (1985) and Wills (1986) investigated the intertidal macrobenthos around the periphery of Stanpit Marsh. The characteristically low diversity fauna of these regions was numerically dominated by Hediste diversicolor, Corophium volutator, Cyathura carinata and Hydrobia ulvae. Other species receiving study have been the shrimps Palaemonetes varians and Crangon crangon (Read, 1981), and the shore crab Carcinus maenas (Charlesworth, 1980). The vegetation of the salt marshes has been described (e.g. Kirckam 1982, Dodd 1983) and the invertebrate populations of the marshes and saltpans have also been studied (e.g. Revell, 1976, Clay 1984). The low level saltmarsh colonising old saltpans is dominated by saltmarsh grass, Puccinellia maritima, sea aster, Aster tripolium, sea lavender, Limonium vulgare, sea arrow-grass, Triglochin maritima, sea plantain, Plantago maritima, mud rush, Juncus gerardii and small amounts of Spartina anglica. Higher level marsh is characterised by sea couch, Elymus pycnanthus, sea rush, Juncus maritimus, and red fescue, Festuca rubra. A rare spike-rush, Eleocharis parvula, occurs in a small area of mud below Stanpit Marsh.

As part of a broad survey on the status of lagoon habitats along the Dorset and Sussex coasts, Sheader and Sheader (1985a) visited two sites within Christchurch Harbour. These were Grimbury pond on the western edge of Grimbury Marsh, and the old man-made harbour system draining into the estuary from the northern side of Hengistbury Head. The Grimbury site had a salinity of 3°/oo and the fauna was characterised by oligochaetes, a variety of crustacea (chiefly Gammarus spp.), and insects. The Hengistbury site on the other hand had salinities varying between 6 - 31 °/oo, and the infauna of the main lagoon, channel and side creeks mainly comprised Streblospio shrubsolii, Hydrobia ulvae, Corophium volutator and a few Hediste diversicolor. Of chief interest however were numbers of the amphipod Gammarus insensibilis which in Britain is apparently restricted to sheltered, shallow brackish habitats. It has only been rarely recorded previously, but may be found more widely as lagoons in general receive more study (Sheader and Sheader, 1985b).

The Wessex Water Authority are currently conducting a 5 year research programme (started in 1986) into the movements of salmon within the harbour and its catchment area.

Outside the harbour off Hengistbury Head and Christchurch Ledge, Collins and Mallinson (1986) have conducted a survey of the sublittoral habitats and communities present on the seabed. Habitats identified were sand, gravel, clay and ironstone boulders. The latter supported the most diverse communities of fauna and flora. They also noted, over a 2-year period, the destruction of large areas of mussel bed (Mytilus edulis) by the common starfish Asterias rubens.

5. SURVEY AIMS AND METHODS

5.1. Introduction

The aims of the fieldwork were:

1. To collect information on the abundance of macrofauna and flora at sites selected to include a wide range of different shore and seabed types, areas of known or likely nature conservation importance, or where rare or unusual species might be present.

2. To collect photographs of the habitats, communities and species present as necessary.

5.2. Fieldwork

The combined intertidal and subtidal survey took place during the period 13th - 18th June 1987 and a total of 32 sites were sampled (Fig. 7 , Table 1). (Fig. 7 folds out at the end of this report.) Sites 1 to 23 were sited on the extensive intertidal sediments, their positions based on a 250 m x 250 m grid with slight modifications to allow for features indicated on the Admiralty chart. All of these sites were accessible on foot, except for Sites 14 and 15 which were remotely sampled from a boat. The remaining sites in the main channel of the estuary were surveyed using a combination of dredging and diving.

Survey methods were based on techniques already developed by the FSC and NCC for intertidal and subtidal sediment sampling. Checklists were used throughout to ensure recording to a consistent format and, for species abundance data, in a form ready for computer filing. All field data sheets are held in Volume 3 of this report.

5.2.1. Sediment intertidal (CH1 - 23). At each site, the habitats present were recorded and notes were taken of features such as shore profile, sediment type and depth of redox discontinuity. Photographs were taken as appropriate. The infauna was then sampled by a combination of coring (4 x 0.01 m^2 cores to a depth of 20 cm) and qualitative recording of the more widely dispersed conspicuous species present. Abundance scales used intertidally are shown in Appendix 1. Core samples were sieved on a 0.5 mm mesh and the retained material preserved in a dilute formaldehyde solution stained with eosin. Sites 14 and 15 were not accessible on foot, and were therefore sampled at high water using a 0.05 m^2 Ponar grab from a locally hired fishing boat, the M.F.V. 'Lucky Lady.' Two samples were obtained an combined from each of these sites, and processed in a similar fashion to the core samples.

5.2.2. Sediment subtidal (DCH 24 - 29). M.F.V. 'Lucky Lady' was also used to deploy a pipe-dredge (25 cm diameter x 90 cm deep) at six sites along the main channel. Much of the conspicuous fauna and flora sampled in this way was identified and recorded in the field, but sediment from each site was sieved on a 0.5 mm mesh and a volume of 1 litre of the retained material preserved for laboratory analysis of the smaller infauna.

5.2.3. Subtidal hard substrata (SCH 30 - 32). The comparative lack of both hard substrata and habitat variety subtidally in Christchurch Harbour (together with fast tidal currents) restricted the number of dive sites to three. During a dive the pair leader determined the separate habitat types from which records were to be made as they were encountered on the seabed. At each one, the habitat type was described and the abundance of conspicuous species was recorded according to the scales given in Appendix 2. Specimens were taken where necessary to assist in accurate identification. Photography at these sites was unsuccessful due to equipment problems and restricted slack water times.

5.3. Data analysis and presentation

5.3.1. Conspicuous species. Field records of the abundance of epifauna/flora and the visible infauna in separate habitats at each site were transferred to a data management programme (Hobbs, 1985). The print-out from these files assists towards a clearer view of the distribution and habitat preferences of each species. From these data, the different habitats and community types encountered during the survey have been identified and summary descriptions written.

5.3.2. Infauna samples. In the laboratory preserved core samples were again washed over a 0.5 mm mesh sieve in order to remove the formalin and any remaining fine sediment. The retained material was then placed in a white tray with some water, and the individual animals (stained red by the eosin dye) picked out, identified and counted. A reference collection containing examples of each species or taxon recorded has been retained at OPRU.

5.3.3. Data analysis. To aid in interpretation of the quantitative data derived from the coring study, a series of faunal indices was calculated for each site, and classification and ordination analyses were also performed. Indices calculated were N (number of individuals), S (number of species or multispecific taxa), and H(s) (Shannon-Weiner information function - a measure of diversity). Prior to classification and ordination, single species occurrences were edited from the data, and a similarity matrix based on Czekanowski Percentage Similarity values was constructed for all pairs of sites. The classification analysis was then carried out following a group average clustering procedure (Lance and Williams 1967) and the ordination consisted of principle co-ordinates analysis (Gower, 1967).

6. RESULTS

6.1. Introduction

Intertidal habitats and communities are described first, followed by those of the subtidal area. In both cases habitat descriptions are ordered, where possible, from the more exposed sites to the most sheltered sites. Photographs are held by the Nature Conservancy Council. Specimens of algae and animals are held in collections at the Oil Pollution Research Unit. Floral and faunal nomenclature follows Howson (1987).

6.2. Intertidal habitats and communities (Sites 1-23).

Two broad habitat types were identified. These were the stones overlying the sediments, together with man-made walls and structures within the estuary, and the large areas of intertidal sediment. The latter category was subdivided into four zones.

6.2.1. Hard substrata within the estuary (1-7 and 10-22). Records of the conspicuous algal and epifaunal species present at each site are included in Table 2.

Gravel, pebbles and occasional small boulders were usually present on the sediments around the high water mark. At lower tidal levels, much of the shoreline in The Run and on the western side of Mudeford Spit was lined with gravel and pebbles but elsewhere in the harbour, the only foci for sessile epibiota were the pebbles, shells, mooring blocks and other objects scattered thinly over the sediment flats. Other hard, stable substrata were provided by the quayside at Mudeford and by the occasional metal jetty and beacon pilings. The partially concreted embankment and walls along the Northern shore of the harbour occasionally fell within the upper shore region.

Diversity was low at all sites, and the coverage or density of individual species was also often restricted as a result of substratum limitations. The most widely recorded species was Enteromorpha sp. which occurred over the whole tidal range and throughout the survey area. Most of the algae recorded belonged to the Chlorophycota, the other widely dispersed species being filamentous green algae, Ulva lactuca and Chaetomorpha sp. Fucus ceranoides, characteristic of upper estuarine and brackish environments, was recorded in limited amounts throughout the main body of the estuary and also occurred on the quayside in The Run. The stony sediments in this narrow entrance (Sites 21 and 22) supported the highest percentage cover of Enteromorpha sp. (Abundant), Ulva lactuca (Common) and Porphyra umbilicalis (Frequent/Common) recorded in the harbour.

Drift specimens of the immigrant seaweed Sargassum muticum were seen at Site 8. This species is well established along parts of the south coast, notably the Solent region, but no attached plants were found during the present survey.

The epifauna observed in the field were predominantly mobile species such as juvenile flatfish (mainly dab, Limanda limanda) and shrimp (Crangon crangon) and unidentified mysid species. Sessile epibiota were only recorded in The Run, these being the slipper limpet, Crepidula fornicata, the mussel, Mytilus edulis and barnacles, Verruca stroemia and Semibalanus balanoides.

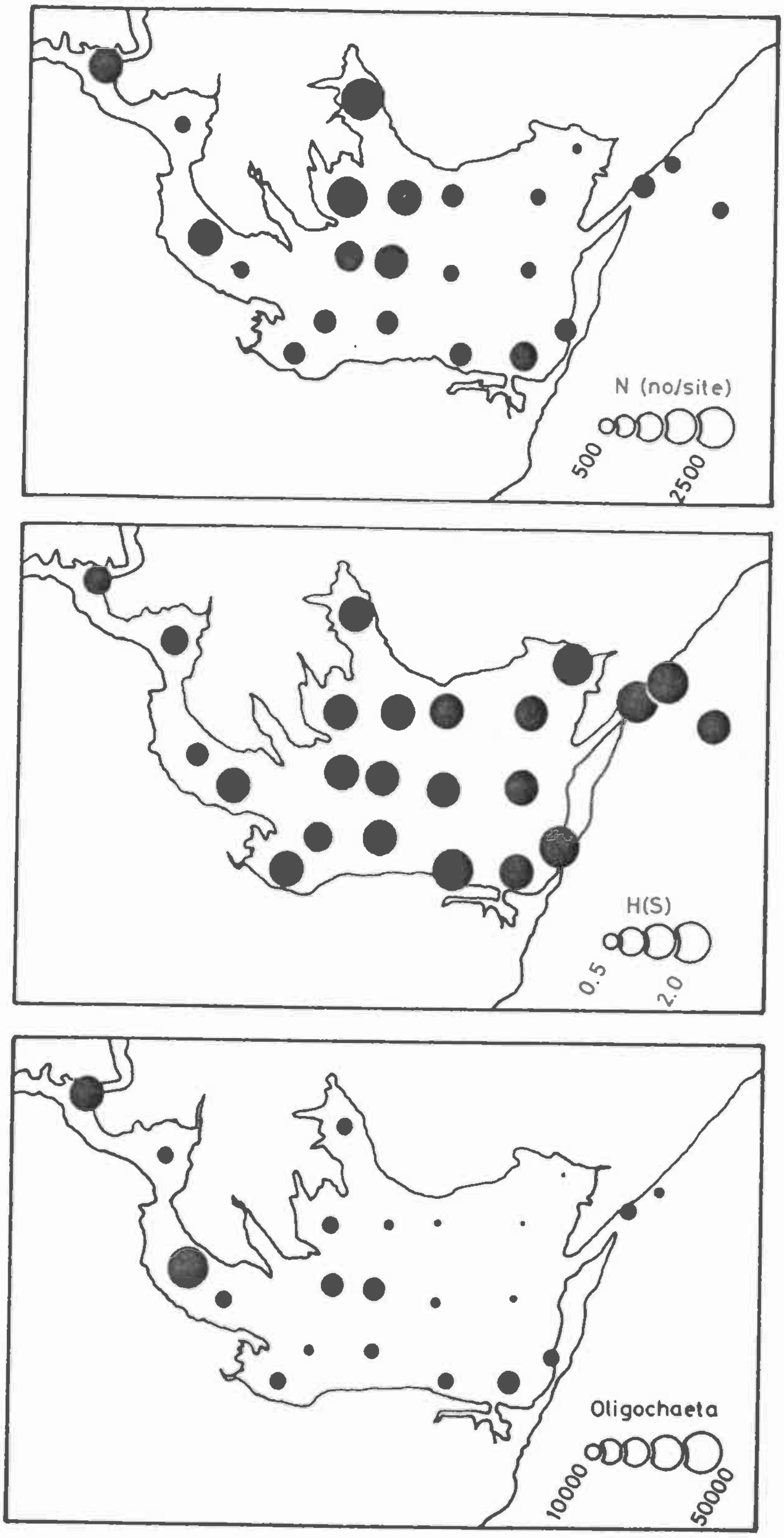
6.2.2. Sedimentary shores (Sites 1-23). The quantitative data from the sediment coring study are shown in Table 3 which also includes the community indices calculated for each site. A total of 45 species (including the multispecific taxa such as Nematoda and Oligochaeta indet), were recognized from 68 samples. The number of species found at each site ranged from 6 (Site 4) to 20 (Site 1) but showed no systematic gradient across the survey area. The total faunal density at each site however tended to increase upstream and into the more sheltered muddy embayments (Fig. 8), varying between 6050 and 66,475 animals per m^2 (at Sites 20 and 9 respectively). This pattern was reflected in the low diversity index values which varied from 0.55 (Site 3) to 2.29 (Site 19) and which tended to increase eastwards across the harbour towards the entrance (Fig. 9).

It can be seen in Table 3 that the crustacea were the most diverse of the major phyla in the harbour, but that the annelida were more numerous. Streblospio shrubsolii, Hediste diversicolor and Oligochaeta indet., which are all typically estuarine species or forms, were particularly abundant at most sites. The oligochaetes dominated the macroinfauna overall, but were most abundant towards the head of the estuary (Fig. 10). S. shrubsolii and H. diversicolor achieved their highest densities in the central region of the harbour and near the sea entrance respectively (Figs. 11 and 12). The other three commonly occurring species, Pygospio elegans, Manayunkia aestuarina and Alkmaria romijni, were not so numerous and showed a slightly more restricted distribution than H. diversicolor and the oligochaetes. As with S. shrubsolii, the sabellid M. aestuarina was only found in the central harbour region (Fig. 13) while the spionid P. elegans favoured the more marine conditions near The Run (Fig. 14). All other polychaetes were much less abundant and only occurred at one or two sample locations. For instance another spionid, Malacoceros fuliginosus and the unidentified paraonid species each occurred at high densities but were restricted to single locations in the outer entrance (Table 3). Species such as Anaitides mucosa, Spio filicornis, Capitella capitata and Arenicola marina which can be both widespread and abundant in estuarine sediments (e.g. Holme and Bishop, 1980; McLusky et al., 1983; Dixon, 1986) occurred only rarely in Christchurch Harbour.

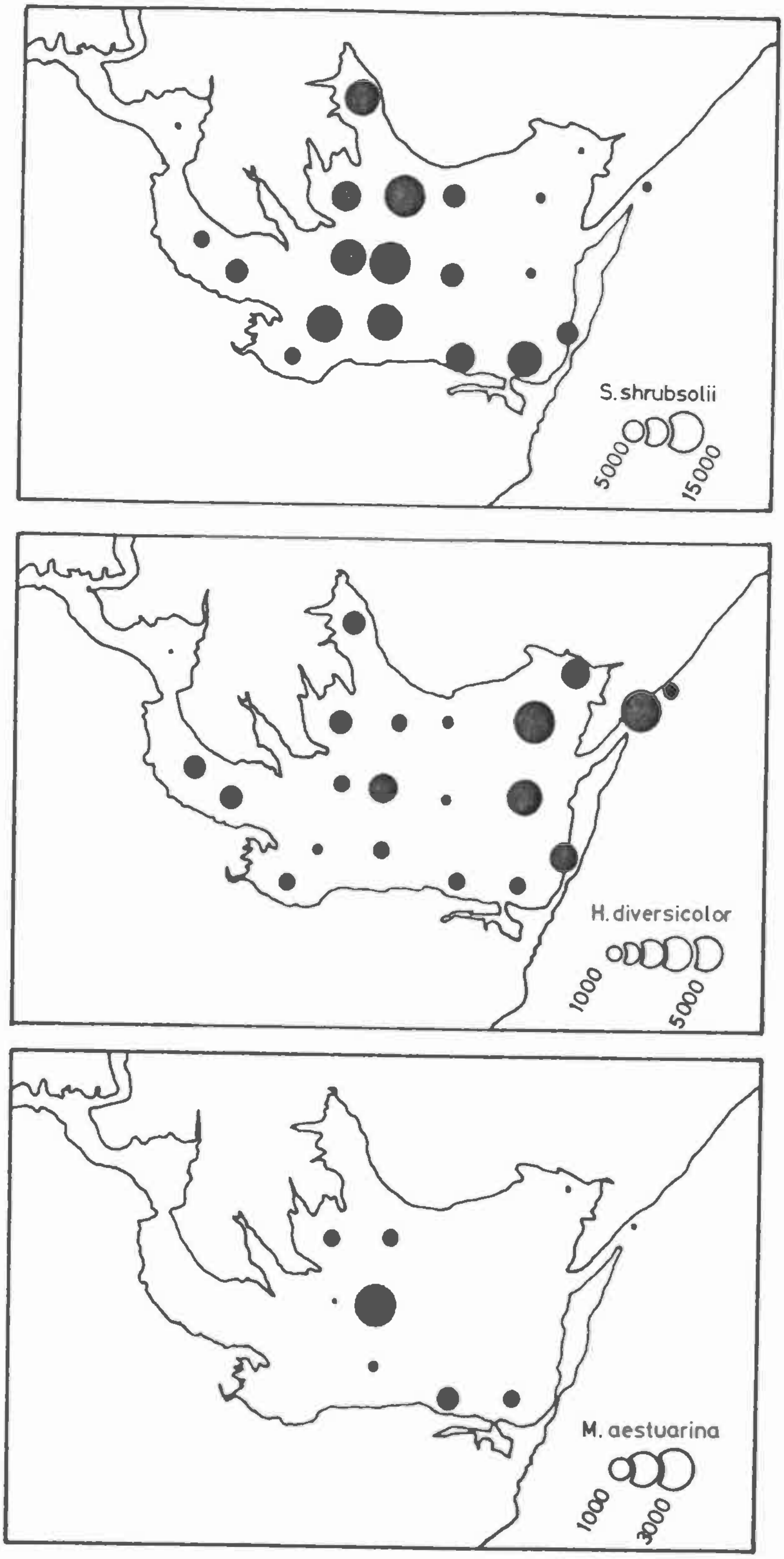
The crustacea were more diverse than the polychaete fauna found, but only the isopod Cyathura carinata and the amphipod Corophium volutator were at all widely distributed. Both were concentrated in the central harbour region and C. volutator reached its peak densities in the muddiest sediment around the eastern edge of Stanpit Marsh (Fig. 15). All other crustacea, with the exception of Crangon crangon, Carcinus maenas and a lone specimen of Leucothoe incisa, were distributed between Sites 1, 2 and 3 near the head of the estuary (Table 3), in common with most of the insect larvae found.

Molluscs were poorly represented in the harbour with only two species being recorded. Although many empty shells of the mud snail Hydrobia ulvae were found in the samples, comparatively few live specimens were present (range 25-425 per m^2). The burrowing bivalve Scrobicularia plana was present in low numbers in the central part of the harbour, but the sampling methods used are not suitable for obtaining precise density estimates of this species. The qualitative data in Table 2, gained in the field by counting siphon marks on the sediment surface, probably give a more realistic impression of the distribution and density of this species.

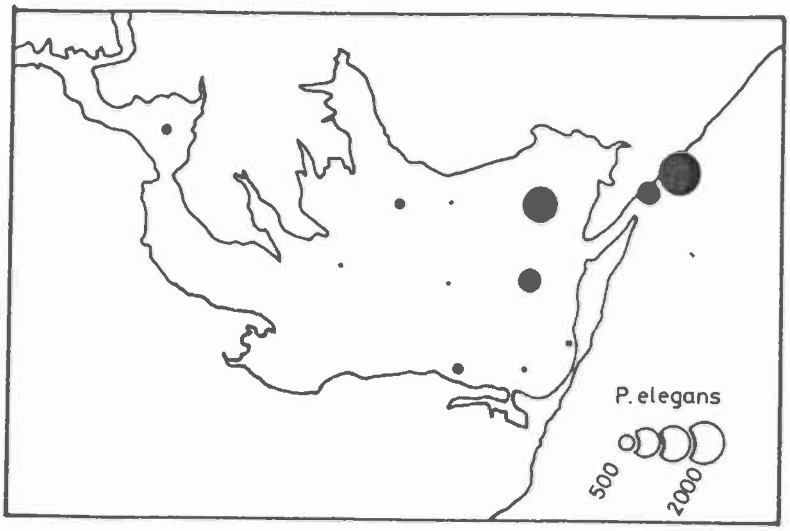
The distribution of the fauna was clearly related to environmental parameters, chief of which was salinity. This is seen in the results of the classification and ordination analyses which has divided the survey area into three groups of sites (Figs. 16 and 17). The scattergram in Fig. 17(a) is a plot of axes 1 and 3 resulting from the ordination procedure, and groups the sites in the same pattern as derived from the classification analysis. (Each of the axes arising from the ordination represents a source of variance, or a gradient, within the data along which sites are ordered and scored. Axis 1 represents the largest source of variance within the data; i.e. the steepest gradient). If axes 1 and 2 are plotted (Fig. 17(b)), sites are grouped in a similar fashion but in a way which accentuates the difference of sites at the head of the estuary from the main block of sites instead of sites at the mouth. On the basis of these data it is possible to identify zones in Christchurch Harbour which reflect macrofaunal succession along the estuary in response to environmental gradients (Fig. 18). These divisions are inexact and probably oversimplify a more complex pattern of biological heterogeneity.

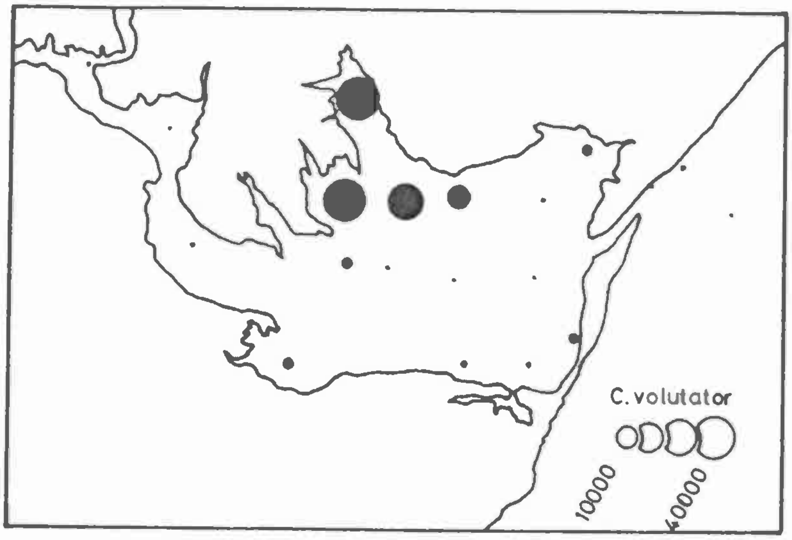


Figs. 8-10. The variation in N (total faunal density per sample), H(s) (diversity), and numbers of Oligochaeta (No. per m^2). Christchurch Harbour, June 1987.



Figs. 11-13. The variation in numbers of Streblospio shrubsolii, Hediste diversicolor and Manayunkia aestuarina across the survey area (No. per m^2). Christchurch Harbour, June 1987.





Figs. 14-15. The variation in numbers of *Pygospio elegans* and *Corophium volutator* across the survey area (No. per m^2). Christchurch Harbour, June 1987.

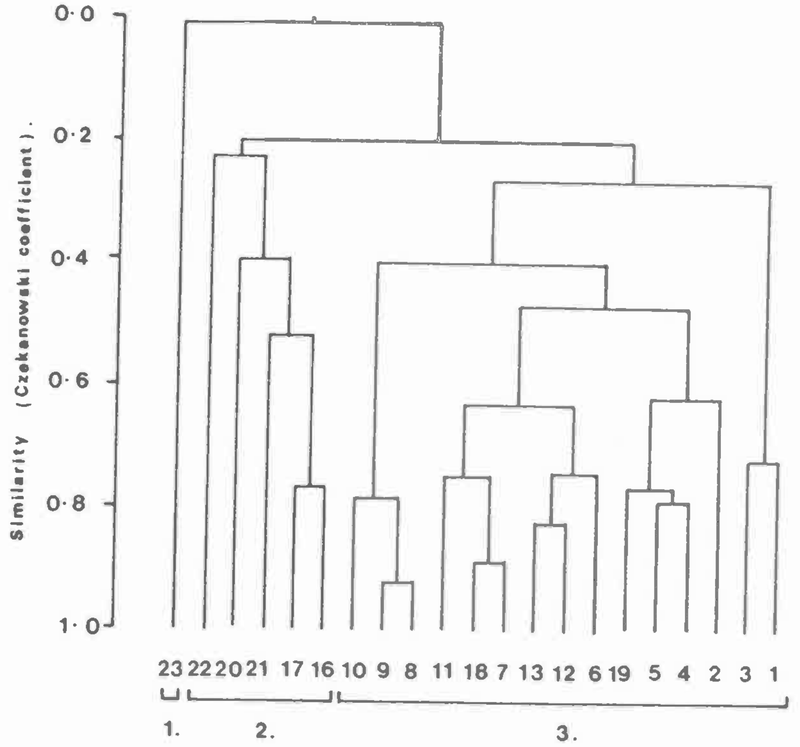


Fig. 16. Dendrogram from classification analysis of the quantitative macrofaunal data (Sites 14 and 15 excluded).

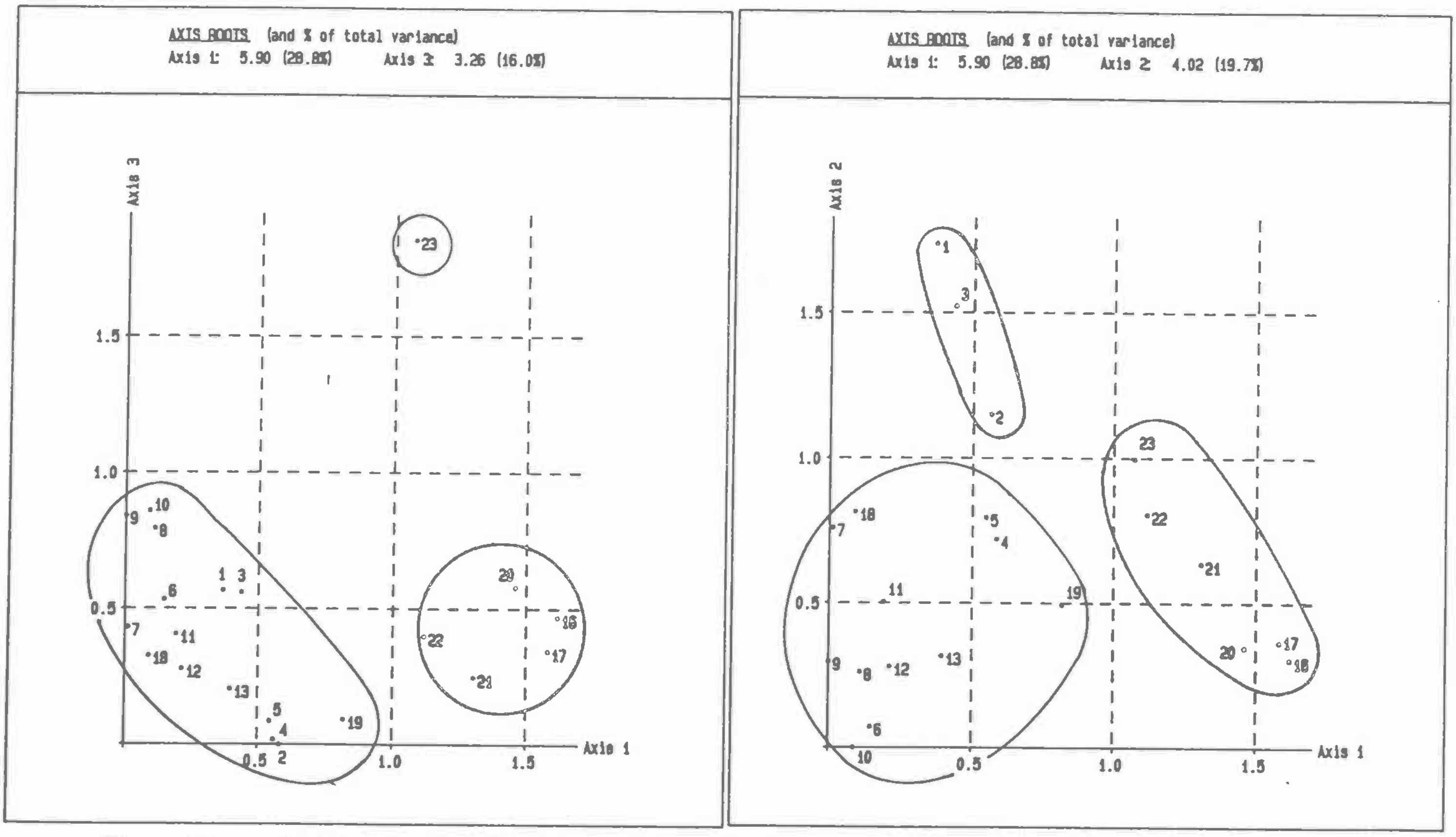


Fig. 17. Scattergrams from ordination analysis of the quantitative macrofaunal data (Sites 14 and 15 excluded). a) Axes 1 and 3. b) Axes 1 and 2.

Fig. 18. Site zones derived from the classification and ordination of the quantitative macrofaunal data. Christchurch Harbour, June 1987.

However, they do broadly illustrate the range of intertidal sedimentary habitat types present. Each of the site groups identified in Figs. 16, 17 and 18 are described below.

1. Open coast lower shore sediments composed of clean sand (Site 23). Low lying tidally swept sands fringing the main channel around the mouth of the estuary. This is the most marine of the habitats identified, and is also subject to wave action.
   The fauna at this site is characteristic of open coast poorly drained lower shore sand, and has very little in common with the fauna found at other sites. The amphipods *Bathyporeia sarsi* and *B. pelagica* were the most abundant species followed by Paraonidea indet and the lugworm, *Arenicola marina*. In addition there were small populations of *Corophium volutator*, the cumacean *Bodotria pulchella*, *Carcinus maenas* and *Crangon crangon*.
   Such a species composition corresponds most closely to the ARENICOLA community of Holme and Bishop (1980) although polychaete diversity in the samples was very low.

2. Sheltered estuarine mixed sediments (Sites 16, 17 and 20-22). This habitat includes the gravelly sediments bordering The Run, the sandbanks built up by flood-tide deposition just inside the harbour entrance, and the muddier sands within the sheltered embayment behind Mudeford spit.

Although salinities in this zone are reduced compared to the open coast, they are higher on average than elsewhere in the harbour since some of the marine inflow on the rising tide is deflected northwards in an anti-clockwise direction by the large river flow.
Species diversity was marginally higher on average at these sites than elsewhere (H(s) range 1.72-2.26), due to factors including higher salinities and greater variety of sediment particle sizes. The infauna here was numerically dominated by polychaetes such as Hediste diversicolor, Pygospio elegans and Streblospio shrubsolii, together with unidentified oligochaete species. Between them, Sites 21 and 22 on the seaward edge of the zone also supported populations of Malacoceros fuliginosus, Capitella capitata and the typically estuarine amphipod Melita palmata.
Sites within this zone do not fall readily into any of the broad community types defined by Holme and Bishop (1980) although they might be described loosely as a reduced salinity variant of the ARENICOLA community. Arenicola marina was actually only recorded from one site (Site 16) as Rare (qualitative records, Table 2).

3. Sheltered fine sediments under brackish-water influence (Sites 4-15, 18 and 19). This zone occupies the major part of Christchurch Harbour. Sediments are composed predominantly of fine sand although mud fractions are dominant at Sites 5, 8, 9 and 10 in the sheltered areas bordering Wick Hams and Stanpit Marshes. Salinities are typically very reduced (relative to full seawater) and often nearly fresh, especially in the southern half of the zone.
Species diversity was low (H(s) range 1.01-2.29) due to the small variety of species and the very high densities attained by one or two populations in particular.
The most abundant species overall were the amphipod Corophium volutator, the spionid polychaete Streblospio shrubsolii and the taxon Oligochaeta indet. C. volutator occurred most abundantly in the muddier reaches of this zone (up to 40,250 per m^2 at Site 9) and S. shrubsolii was more evenly distributed with densities of between approximately 3 and 14 times greater than were recorded in zone 2. Other species not so ubiquitous or abundant, but nevertheless characteristic of this zone, were the ampharetid Alkmaria romijni, the small sabellid Manayunkia aestuarina, the isopod Cyathura carinata and the bivalve Scrobicularia plana. The ragworm Hediste diversicolor was present at all sites here, but was not as abundant as in zone 2.
Sites within zone 3 correspond most closely to the SCROBICULARIA community of Holme and Bishop (1980).

4. Current-swept mixed sediments under fresh or brackish-water influence (Sites 1-3). Sediments are mixed in this zone and include the coarser fractions up to gravel and pebbles at certain points because of fast river currents. Salinities are almost fresh much of the time, although saline bottom water can intrude as a salt wedge up as far as the normal tidal limit under dry summer conditions,
Twenty taxa were recorded from Site 1 (more than anywhere else) although diversity values here and at Sites 2 and 3 were very reduced (H(s) range 0.55-1.20) due to the absolute numerical dominance of the fauna by the single multispecific taxon, Oligochaeta indet.
As well as oligochaetes, the samples included numbers of insect larvae, a cladoceran, ostracods, at least two species of the genus Gammarus, the freshwater isopod Asellus aquaticus, and single specimens of an estuarine tanaid (Heterotanais oerstedi) and the eel Anguilla anguilla.

6.3. Subtidal habitats and communities (Sites 24-32).

Subtidal habitats were sampled at a total of 9 sites of which only 3 were surveyed by divers. Habitats were limited in variety, being relatively shallow (all only just subtidal), basically sedimentary in nature, and confined (with one exception) to a long narrow channel with fast currents and reduced salinities. There was a good overlap between the dived sites and remotely sampled sites, and for these reasons the two data sets have been combined. The species collected by dredging are listed in Table 4. A total of six habitats were identified.

6.3.1. Offshore infralittoral ironstone bedrock or stable boulders (Site 31). This habitat occurs approximately 0.5 km directly offshore from the entrance to The Run, and represents an isolated outcrop of the main ironstone exposures off Hengistbury Head, 1.5 km to the south west.

These outcrops, surrounded by a sediment plain, were dominated by foliose brown and red algal species, especially Dictyota dichotoma, Plocamium cartilagineum and Polysiphonia nigrescens. Foliose animal forms were also prominent including Hydrallmania falcata, Vesicularia spinosa, and the smaller Bugula plumosa. The rock surface itself was encrusted predominantly with Balanus crenatus, together with Actinothoe sphyrodeta, Pomatoceros sp. (p) and Clavelina lepadiformis. The gastropod Trivia arctica was recorded as Common here, and Sagartia troglodytes occurred on the lower sand-covered parts of the rock. The community recorded on rock/boulders at Site 31 is listed below:

Common species:	Plocamium cartilagineum, Polysiphonia nigrescens, Balanus crenatus, Trivia arctica.
Frequent species:	Brongniartella byssoides, Ceramium rubrum. Cordylecladia erecta, Cryptopleura ramosa, Grateloupia filicina, Griffithsia flosculosa, Polysiphonia elongata, Dictyota dichotoma.
Occasional species:	Calliblepharis ciliata, Corallinacea indet. (pink encr.), Delesseria sanguinea, Gymnogongrus crenulatus, Heterosiphonia plumosa, Hypoglossum hypoglossoides, Phyllophora crispa, P. pseudoceranoides, Polyides rotundus, Rhodomela confervoides, Gracilaria verrucosa, Ceramium diaphanum agg. Polysiphonia nigra, Chondria dasyphylla, Taonia atomaria, Bryopsis plumosa, Cladophora sp. Chlorophycota indet., Hydrallmania falcata, Actinothoe sphyrodeta, Pomatoceros sp. (p), Bugula plumosa, Vesicularia spinosa.
Rare species:	Sagartia troglodytes, Liocarcinus puber, Clavelina lepadiformis.

Also in this habitat a number of algal and animal species were recorded as solely occurring on algae. These were as follows:

Common species:	Ectocarpacea indet.
Occasional species:	Lomentaria clavellosa, Rhodophyllis divaricata, Audouinella sp., Scypha ciliata, Electra pilosa.
Rare species:	Halichondria bowerbanki.

Present (no record of abundance):	Spermothamnion irregulare.

6.3.2. Offshore infralittoral cobbles and pebbles (Site 31). This relatively stable habitat occurs in the vicinity of the offshore rock/boulder outcrop described above, and is also influenced by the sandy sediments. These stones were algal-dominated, mainly by Polysiphonia nigrescens and unidentified filamentous green species, although Polyides rotundus and Gracilaria verrucosa were both recorded frequently also. Upper surfaces were encrusted by Balanus crenatus and Pomatoceros sp. (p), and Actinothoe sphyrodeta also occurred here. The species found in this habitat are listed below:

Abundant species:	Balanus crenatus.
Common species:	Polysiphonia nigrescens, Chlorophycota indet.
Frequent species:	Polyides rotundus, Polysiphonia sp., Gracilaria verrucosa, Cladophora sp., Pomatoceros sp. (p).
Occasional species:	Cordylecladia erecta, Chondria dasyphylla, Taonia atomaria, Actinothoe sphyrodeta, Crepidula fornicata.

6.3.3. Offshore clean sandy sediments (Sites 24 and 31). This habitat consists of stones and flint chips overlain by fine sand, and is probably the major offshore subtidal habitat type along this stretch of shallow coastline.

Algae were patchy and scarce, consisting of small specimens of Plocamium cartilagineum, Enteromorpha sp., and Ceramium rubrum (Site 24). The epifauna was dominated by mobile predatory species such as Pagurus bernhardus, Hinia reticulata and Pomatoschistus pictus. The infauna was fairly rich (Table 4) and was dominated by polychaetes, in particular the sand mason worm Lanice conchilega. The other main species picked up in the dredge included Scoloplos armiger, Eumida sanguinea, Chaetozone setosa and the amphipod Atylus swammerdami. The fauna recorded from this habitat at Site 31 is listed below:

Abundant species:	Hinia reticulata.
Common species:	Lanice conchilega, Pagurus bernhardus, Pomatoschistus pictus.
Occasional species:	?Phoronis sp.

6.3.4. Estuarine current-swept vertical concrete or metal surfaces and small boulders (Sites 30 and 32). This habitat occurs on the vertical quay wall at Mudeford, and on the pilings and pontoons of the Hengistbury ferry jetty, in the depth range +0.5 - 2.2 m BCD. A tumble of small boulders is present at the base of the quayside at Mudeford. In addition to fast tidal currents, this habitat is also subjected to reduced salinities.

The dominant species at both sites was Callithamnion ?tetricum which occurred at up to 90% cover. The hydroid Obelia ?dichotoma was also commonly recorded from the quay wall, but not on Hengistbury jetty where the commonly recorded co-occurring species was Enteromorpha sp. Other species, which in this habitat were only recorded from the quay wall, included Carcinus maenas, Mytilus edulis and Littorina littorea. Below chart datum level, O. ?dichotoma and M. edulis provided the main coverage, both on the wall and on the boulders, although Polydora sp. occurred only on the boulders. The subtidal community recorded on the Mudeford quayside is listed below:

Abundant species:	Callithamnion ?tetricum.
Common species:	Obelia ?dichotoma, Polydora sp., Carcinus maenas, Mytilus edulis.
Occasional species:	Ulva lactuca, Enteromorpha sp., Littorina littorea.
Rare species:	Chaetomorpha linum.

6.3.5. Estuarine current-swept cobbles and pebbles on sandy sediments. (Sites 25, 26, 30 and 32). These were large rounded cobbles and pebbles with little growing on them apart from Occasional or Rare specimens of Obelia ?dichotoma, Hydrallmania falcata and Balanus crenatus (in The Run) and Enteromorpha sp and Callithamnion ?tetricum at Site 32. Other epifaunal and more mobile species common to both areas in the diving and dredge data included Carcinus maenas and Crepidula fornicata. The fauna of these habitats (sites 25 and 26, Table 4) represented the transition between marine - estuarine and brackish - estuarine conditions. In The Run, species dominating the samples numerically were Malacoceros fuliginosus, Lanice conchilega, and Hediste diversicolor. Further into the harbour at site 26, the fauna consisted mainly of Oligochaetes, Capitella capitata, Streblospio shrubsolii and Hediste diversicolor. The infauna at sites 25 and 26 is therefore very similar to that recorded from adjacent intertidal areas at sites 22 and 19 respectively.

The species list from this habitat at site 30 is shown below:

Frequent species:	Carcinus maenas
Occasional species:	Obelia ?dichotoma
Rare species:	Hydrallmania falcata, Arenicola marina, Lanice conchilega, Balanus crenatus, Amphipoda indet., Crangon crangon, Littorina littorea, Crepidula fornicata, Mytilus edulis, Pholis gunnelus, Taurulus bubalis.
Drift specimen:	Flustra folicea

6.3.6 Brackish estuarine muddy sands (sites 27 - 29 and 32). The habitats and biota recorded from the dredge at these sites were closely comparable to those quantitatively recorded from intertidal sites throughout the main body of the harbour (c.f. Tables 3 and 4). Algae (either Enteromorpha sp. or Chaetomorpha sp.) were sparse and the infauna was dominated by Streblospio shrubsolii and Oligochaeta indet. Hediste diversicolor decreased in abundance upstream with decreasing salinity. These dredge samples fall readily into the habitat category 'zone 3' which was defined on the basis of intertidal macro-infauna. Intertidally the approximate transition between this zone, and the almost freshwater zone 4, occurred close to the Marine Training Centre (Fig. 18).

7. DISCUSSION

7.1 Distribution of habitats and communities.

7.1.1. Intertidal

Substrata and habitats. Ordnance Survey maps (e.g. Pathfinder Series, 1:25,000, sheet SZ 09/19 Bournemouth) and Admiralty chart no. 2219 provide a certain amount of synoptic information on shore types and substrata within Christchurch Harbour. A survey of harbour-bed sediments was carried out in 1984 (V.J.May, unpublished data) and the present survey provides an additional description of topographical and sedimentary features of the shores sampled. Physiographic and sedimentological features change with increasing distance from the coast, and from the influences of riverine and tidal flow. These features are summarised below:

- In general the estuary's coastline and hinterland are low-lying and all shores are sedimentary in nature. The exception to this is Hengistbury Head, south of the harbour, which is 36 m in height and where outcrops of ironstone bedrock and boulders occur on the open coast.

- The entrance to the harbour on the open coast is occluded by a double spit structure of sand and shingle deposited by longshore drift. This has the effect of sheltering the harbour from occasional south or south-easterly gales and wave action. It also restricts the direct river flow from the Avon and Stour to the sea on the one hand, and marine inflow on the other, with a resultant salinity reduction over the whole harbour.

- The harbour is predominantly intertidal although periods of highwater can be extended due to the unusual tidal regime. The tidal range is small, being 1.4 m on springs.

- At the coast and in the estuary entrance sediments are of fine sand and gravel or pebbles. In the main body of the estuary, intertidal sediments are of fine sand with the mud content increasing into the sheltered embayments behind the spits and in the creeks, channels and bays of Stanpit and Wick Hams Marshes.

- Stable hard substrata in the harbour were rare and were provided chiefly by man-made structures and by thinly scattered stones and shells on the sediment surface.

Communities and species.

- The single main factor influencing the distribution, density and diversity of marine or estuarine fauna and flora was salinity, which was reduced (relative to seawater) over the whole estuary.

- Floral and epifaunal diversity was low throughout the estuary. The lack of stable hard substrata was a limiting factor here, in addition to the reduced salinities.

- Enteromorpha sp (p) were the most widely distributed algae, together with other Chlorophycota. Fucus ceranoides, characteristic of estuarine and brackish conditions, was recorded in very limited amounts between the mouth of the harbour and Wick Hams. Drift specimens of the immigrant seaweed species Sargassum muticum were found during the survey.

- The most ubiquitous epifauna present were the mobile forms typical of estuarine areas, such as Carcinus maenas, Crangon crangon, and juvenile flatfish. Sessile epifauna were only recorded from The Run, and included sparse populations of Semibalanus balanoides, Verruca stroemia, Mytilus edulis and Crepidula fornicata.

- The sediment macroinfauna was numerically dominated at most sites by oligochaete species, Streblospio shrubsolii, Hediste diversicolor, and Corophium volutator. Faunal succession down the length of the harbour was very gradual right up to the entrance where the degree of marine influence was suddenly increased within the length of The Run.

- Sedimentary habitats were classified into four types on the basis of macrofauna samples.

- Open coast sandy beach sediments at the mouth of the estuary, where the marine influence was greatest, were characterised by large numbers of Bathyporeia species and Arenicola marina.

- An area of mixed sediments (mainly sand) occurred in The Run, which extended a short way into the harbour. In this zone, the transition occurred from a marine - estuarine fauna dominated by Hediste diversicolor, Pygospio elegans, and Malacoceros fuliginosus, to a brackish - estuarine fauna characterised by Streblospio shrubsolii, Hediste diversicolor and oligochaetes.

- In the main body of the harbour, sediments supported an infauna composed predominantly of Streblospio shrubsolii, Corophium volutator, oligochaete species and Hediste diversicolor.

- Mixed sediments in the confined channel west of Wick Hams were dominated by oligochaete species. Taxa more characteristic of freshwater or brackish environments occurred here such as insect larvae, Asellus aquaticus and Gammarus ? zaddachi. Very few estuarine species were identified from these samples, and the abundance of Hediste diversicolor and Corophium volutator, for example, decreased sharply upstream in this zone.

7.1.2. Subtidal

Substrata and habitats. Limited information on seabed types is available from Admiralty Chart no. 2219. The present survey provides a description of the seabed at sites either dredged or dived. The nature of Christchurch Harbour, with its shallow river channel flanked by extensive sediment flats, permits the supposition that subtidal substrata are largely similar to those of the intertidal area.

- All subtidal sites were very shallow, and were tidally scoured.

- Ironstone bedrock and boulders occurred subtidally off Hengistbury head. Isolated outcrops also occurred 0.5 km outside the harbour mouth.

- Outside the harbour the predominant seabed habitats were clean fine sand overlying flint pebbles, together with less extensive patches of stable cobbles and pebbles overlying sand.

- In The Run, and just inside the harbour, sizeable areas of hard substrata were available for colonisation in the form of a vertical quay wall with boulders at the base, and the vertical metal and concrete surfaces on the Hengistbury ferry jetty.

- In the same region, the seabed was covered with unstable current-swept cobbles and pebbles.

- Within the main body of the harbour, the channel bed consisted predominantly of fine muddy sands which were similar to adjacent intertidal sediments.

Communities and species

- Algal, epifaunal and infaunal diversity declined sharply along the length of The Run into the harbour, and then tended to decrease very much more gradually upstream along the channel.

- Marine bedrock and boulders outside the entrance supported a wide variety of algae and epifauna. The sand and cobble habitats in the same locality supported a smaller variety of epibiota, but sediment samples were rich in macroinfaunal species.

- Vertical surfaces in, or in the vicinity of, The Run were colonised by very few species, these being Callithamnion ?tetricum, Obelia ?dichotoma and Enteromorpha sp.

- Epifauna and flora on the bed of The Run were of low diversity and, from here upstream, were similar to that described for the intertidal.

- The same was true for the infauna which was largely an extension of that found intertidally.

7.2. Comparison with previous marine biological studies.

Outside the harbour, the subtidal habitats, examined briefly by diving and dredging, were identical to those identified and described by Collins and Mallinson (1986). During the present survey, the subtidal clay and circalittoral ironstone boulder habitats further to the south west were not investigated. Overall, the fauna and flora identified from subtidal boulders, cobbles and sand in both studies were closely comparable, and yielded few surprises for this stretch of coast. The alga Taonia atomaria, and the leopard-spotted goby Thorogobius ephippiatus are now known to be more widely distributed than previously believed, before the advent of SCUBA diving as a marine biological tool.

Intertidally, the occurrence of Fucus ceranoides was limited by the lack of suitable attachment points, but its presence in The Run on Mudeford Quay illustrates the degree to which salinity reduction occurs, even at the sea entrance.

Inside the harbour, the habitats and communities of the main channel can be considered along with those of the intertidal areas, and no similar investigations have been carried out in the past on which to base a direct comparison. The recent student studies around Stanpit Marsh (e.g. Wills 1986) recorded most of the numerically dominant species found during the present survey. They also noted the particular abundance of Corophium volutator in the muddy bay between Stanpit and Stanpit Marsh. The low-diversity infauna dominated by Streblospio shrubsolii reported from Holloway's Lake (Sheader and Sheader, 1985a) was closely related to that found in the main body of the estuary.

The subdivision of the survey area into four zones, based on the macrofaunal data, is very similar to the zonation suggested by Whittaker (1981) on the basis of the ostracod fauna. (A 75 um sieve mesh was used by Whittaker, as opposed to the 500 um mesh used here which accounts for the virtual absence of ostracods from our records).

Although the macrofauna here has affinities with that of the upper, muddy, reaches of many other estuaries on the south coast (see Holme and Bishop, 1980 for summary), it does not show the gradual succession between marine and brackish conditions which typically occurs over much of the length of an estuary. As noted by Murray (1986) and Whittaker (1981), this transition in Christchurch Harbour takes place virtually within the short length of The Run, while over the greater part of the basin the fauna is relatively uniform. On this basis, together with the already well observed physiographic and hydrographic features of the water body, it can be argued that Christchurch Harbour is a large lagoon, or at least an estuary with distinctly lagoonal properties. The sea entrance is occluded, the tidal range is small, and the periods of high water are extended by the unusual tidal regime of the coastline. Set against this relative environmental stability, is the seasonal fluctuation in the penetration of saline water with a consequent flux in certain faunal distributions (Murray, 1968, Whittaker, 1981).

The harbour was not included directly in the recent inventory of lagoons on the Dorset - Sussex coast (Sheader and Sheader, 1985a) although two sites within the harbour were investigated (see section 4). The benthic macroinfauna found over the greater part of Christchurch Harbour has similarities with the fauna sampled from some of the lagoons in the above inventory such as Titchfield Haven, Hook, the Keyhaven - Pennington lagoon system and the Warren Park shore lagoons for instance. Gammarus insensibilis was recorded from Holloway's Lake (Sheader and Sheader 1985a) and in Britain this species is regarded as being limited to sheltered lagoonal habitats (Sheader and Sheader, 1985b). The fact that it was not recorded more widely in the harbour is perhaps due to the absence of its main food item, Chaetomorpha sp., over much of the survey area, and/or the lesser degree of shelter available in such a wide open habitat.

Whether Christchurch Harbour is described as an estuary, a lagoon or a mixture of both depends on a classification system which at the moment is not at all clear. What is evident however, and has been stressed by previous authors, is that Christchurch Harbour is an unusual coastal environment.

8. ASSESSMENT OF SCIENTIFIC INTEREST AND NATURE CONSERVATION IMPORTANCE OF THE CHRISTCHURCH HARBOUR.

8.1. Introduction.

The assessment of scientific interest and nature conservation importance has been undertaken through a general evaluation which follows the criteria outlined by Mitchell (1986) (Section 8.2) and by ranking the conservation importance of the habitats and communities encountered and of species considered of conservation interest (Section 8.3). The conclusion of these exercises is given in Section 8.4. The criteria used here to assess conservation importance are applied in the manner outlined in the NCC 'Handbook for the Preparation of Management Plans" (1st edition, February 1983) but defined in relation to northeast Atlantic marine ecosystems. The definitions were first used in the management plan for the Lundy marine nature reserve and have subsequently been used for the Skomer marine nature reserve management plan and to evaluate marine ecosystems in the Isles of Scilly and the area of Bardsey and the Lleyn Peninsula. They are to be used for each area included in the Surveys of Harbours, Rias and Estuaries but are provisional until comparison of the majority of areas is possible.

8.2. General evaluation

Naturalness. The harbour and its shoreline have remained largely natural in appearance, with the exception of comparatively minor quay facilities at Christchurch, and the old villages of Stanpit and Mudeford along the north shore. The coastal conurbation to the east of Bournemouth skirts around Christchurch Harbour and its immediate hinterland, and is village/residential in nature.

Subtidally, the main channel is maintained by periodic dredging. The resultant spoil has been used to augment the Hengistbury spit, which also requires coastal protection in the form of groynes, to prevent its disappearance.

In spite of being adjacent to the Solent system, this section of the coast has not changed significantly through the introduction of adventive species. *Crepidula fornicata* was not particularly abundant at the harbour entrance, and was not found at all within the harbour. Similarly, *Sargassum muticum* in the harbour was only represented by one drift specimen. There is no shellfish mariculture to introduce foreign species into Christchurch Harbour although stocks of *Mercenaria mercenaria* dredged from the Solent are occasionally stored here in keep-bags.

Representativeness. Most of the intertidal and subtidal habitats and communities are commonly found in other coastal inlets, often in larger areas. As an example of an estuary, or even as a lagoon, better representatives are to be found elsewhere. However, with its unusual combination of physiography, high riverine/low marine inputs and atypical tidal regime, Christchurch Harbour as a whole stands possibly unique in the context of southern British coastal inlets.

Rarity. None of the communities found or their constituent species are rare. Certain species recorded from the harbour by other workers, however, are only rarely found elsewhere, or have a distribution that is restricted or inadequately known. Of the ostracod fauna, *Cytherois stephanidesi* and *Callistocythere murrayi* (brackish muddy habitats) have been infrequently recorded in Britain. The former is possibly restricted to the south coast, near its northern limit of distribution. The latter was originally described from Christchurch Harbour and has subsequently been recorded from locations on the east and west coasts. The amphipod Gammarus insensibilis has been recorded from a few lagoonal habitats along the central south coast.

Diversity. The diversity of habitats and communities in general is low. The highest species diversities were recorded outside the harbour on ironstone boulders and in the clean fine sediments. Within the harbour, productivity of the sedimentary infauna was very high.

Fragility. Historical records of intertidal or subtidal marine communities in the survey area with which to compare the results from the present study do not exist. Thus a direct assessment of the degree of change, or of the resilience of the flora and fauna following disturbance cannot be made. However, while all biological communities are susceptible to alteration through human intervention, those of Christchurch Harbour are not likely to be intrinsically very sensitive.

Size. Christchurch Harbour is approximately 2 km^2 in area. Almost half of this area consists of saltmarsh, while the remainder consists of intertidal sediment flats.

Situation. Christchurch Harbour is situated on the south coast midway between Poole Harbour and the Solent. The coastline is sedimentary in nature and subject to erosion by the sea. The area has importance as a landfall and dispersal point for migrating birds crossing the Channel.

Recorded history. There is very little published work on the marine, estuarine or brackish habitats of Christchurch. All such work has been carried out since the early 1960's, and has concentrated on two meiofaunal groups, the Foraminiferida and the Ostracoda. However, this work has been thorough, synoptic, and has included a great deal of useful physical and chemical information. Mother Siller's Channel is the type locality for Callistocythere murrayi Whittaker.

Research and education potential. In addition to the intertidal and subtidal areas, Christchurch Harbour has a wide variety of habitats. The locality is also interesting geologically, geographically and historically and full use has been made of all these resources in environmental education and interpretation. Much of this material is available in 'Teaching packs', prepared at the Marine Training Centre. The sheltered shallow waters of the harbour are also recognised as being ideal for the teaching of sailing, canoeing and other water sports.

Restoration potential. There are no areas intertidally or subtidally where restoration work is required.

Intrinsic appeal. Christchurch, its harbour and the surrounding villages are scenically attractive. Its appeal is mainly to those interested in water-based recreation.

Vulnerability/Threats. There are no major threats to the flora and fauna of the intertidal and subtidal areas. Bait digging is a possible source of disturbance although its extent is not known. This disturbance is presumably minimised by the double, or extended, high water periods. Pollution from any source does not appear to have affected the estuarine/brackish biota to date.

Perhaps the major threat to the area in general is visitor pressure which in turn could affect the harbour's use by breeding and roosting estuarine bird populations.

Urgency. None.

Feasibility. The whole harbour, with the exception of The Run and Hengistbury spit, is served with an SSSI designation, while Stanpit Marsh is also a Local Nature Reserve.

8.3 Identification/confirmation of important features.

Features of littoral and sublittoral ecosystems in the area of Christchurch Harbour are evaluated here in terms of their International, National, Regional or Local importance. Table 5 lists the main habitat/community types encountered and Table 6 lists species which are considered of scientific interest in their presence in the survey area. For Table 5, the separation of habitat type is according to Section 6. The rating of importance is made broadly according to the following definitions:

International. Communities which are outstandingly good examples of their type in the Northeast Atlantic. Communities recorded at only a very few locations in the Northeast Atlantic.

Species which are recorded at only a few locations in the Northeast Atlantic. Species recorded in higher abundance in the area under consideration than anywhere else in the Northeast Atlantic or where the area is one of only a very few locations where large quantities are recorded.

National. Communities which are outstandingly good examples of their type in Britain. Communities recorded in only a very few marine inlets or estuaries in Britain. Both of these definitions refer to communities which are or are likely to be widely occurring in other inlets and estuaries in the Northeast Atlantic.

Species which are recorded at only a few locations in Britain but are more widespread in other parts of the Northeast Atlantic. Species recorded in higher abundance at the inlet or estuary under consideration than in any other elsewhere in Britain or where the site is one of only a very few locations where large quantities are recorded in Britain.

Regional. Communities which are present in inlets and estuaries elsewhere in Britain but which are outstandingly good examples of their type in the inlet or estuary under consideration or are as good examples as similar communities present elsewhere in Britain. Communities recorded at only a few locations in inlets and estuaries in south Britain.

Species which are unrecorded or recorded at only a few locations in inlets and estuaries in south Britain but are widespread in other inlets and estuaries or on the open coast in other parts of Britain. Species recorded in higher abundance in the area under consideration than in any other inlet or estuary in south Britain or where the site is one of only a very few locations where large quantities are recorded in south Britain.

Local. Communities which are widespread in inlets and estuaries in south Britain with as good or better examples at several other locations.

The selection only of species which are of higher than Local importance precludes the use of this category in species lists.

8.4. Conclusion.

Christchurch Harbour is a small unit, and can be described as an estuary with lagoonal properties. Although the diversity of intertidal and subtidal habitats is not high, the infauna of the sediments is very productive. The brackish marsh creeks and lagoons support at least three invertebrates thought to be rare in Britain, and past studies have highlighted the unique nature of the harbour's hydrography. The system is relatively unpolluted and of considerable scenic appeal. It therefore seems appropriate to ensure that these features are maintained through the SSSI designation that already exists.

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List of Tables

TABLE 1

CHRISTCHURCH HARBOUR

Sites surveyed

Site No.	Site Name	OS Grid Ref	Samples taken	Flora	Fauna	Habitat	Date Surveyed
CH 1		SZ 1617 9226	4x0.01 m cores			IMTD/DL	15.6.87
2		SZ 1652 9203	"			AEL/DL/SH	14.6.87
3		SZ 1663 9152	"			AEL/DL/SH	15.6.87
4		SZ 1675 9138	"			AEL/DL/SH	14.6.87
5		SZ 1700 9100	"			IMTD/CMH	15.6.87
6		SZ 1717 9118	"			AEL/DL/SH	15.6.87
7		SZ 1727 9147	"			AEL/DL/SH	14.6.87
8		SZ 1727 9174	"			AEL/DL/SH	14.6.87
9		SZ 1730 9216	"			IMTD/CMH	15.6.87
10		SZ 1751 9168	"			AEL/DL/SH	14.6.87
11		SZ 1743 9143	"			AEL/DL/SH	14.6.87
12		SZ 1743 9117	"			AEL/DL/SH	15.6.87
13		SZ 1780 9102	"			AEL/DL/SH	15.6.87
14		SZ 1770 9147	"			IMTD/DL/CMH	14.6.87
15		SZ 1770 9170	"			IMTD/DL/CMH	15.6.87
16		SZ 1814 9168	"			AEL/DL/SH	15.6.87
17		SZ 1807 9140	"			AEL/DL/SH	15.6.87
18		SZ 1800 9103	"			IMTD/CMH	14.6.87
19		SZ 1820 9118	"			IMTD/CMH	14.6.87
20		SZ 1826 9196	"			IMTD/CMH	15.6.87
21		SZ 1850 9173	"			IMTD/CMH	14.6.87
22		SZ 1865 9185	"			IMTD/CMH	15.6.87
23		SZ 1866 9172	"			IMTD/CMH	14.6.87
D CH 24	Outer entrance	SZ 1887 9171 to 1879 9182	1 full pipe dredge (44 L)			IMTD/DL/CMH	15.6.87
25	The Run	SZ 1840 9166 to 1822 9151	"			"	15.6.87
26	Off Hengistbury Jetty	SZ 1816 9120 to 1783 9109	"			"	15.6.87
27	Blackberry Point	SZ 1731 9112 to 1700 9125	"			"	15.6.87
28	Grimbury Marsh	SZ 1673 9150 to 1653 9171	"			"	15.6.87
29	Inner Reach	SZ 1840 9169 to 1625 9206	"			"	15.6.87
S CH 30	Mudeford Quay and The Run	SZ 1840 9169 to 1839 9165		CMH	SH	CMH/SH	16.6.87
31	Entrance Rocks	SZ 1941 9110		AEL	DL	AEL/DL	16.6.87
32	Hengistbury Jetty	SZ 1815 9119		IMTD	IMTD	IMTD	16.6.87

Table 2.

Qualitative data for conspicuous intertidal species.

KEY: E = Extremely abundant; A = Abundant; C = Common; F = Frequent; O = Occasional; R = Rare; P = Present (no record of abundance); D = Drift specimens.
(Abundance scales are given in Appendix 1)

Site No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
PLANTS																							
Enteromorhpa sp.	O	-	O	O	O	-	O	-	-	-	O	O	O	-	-	-	O	O	O	-	A	A	-
Caposiphon fulvescens	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaucheria sp.	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ulothrix pseudoflacca	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zostera sp.	-	R	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophycota indet. (Fil.)	-	R	O	R	-	-	-	-	-	-	O	-	O	-	-	-	-	-	-	-	-	-	-
Bacillariophyceae indet.	-	F	-	-	-	F	-	-	-	-	-	-	-	-	-	-	O	-	-	-	-	-	-
Ceramium rubrum	-	-	D	D	-	D	-	D	-	-	-	O	D	-	-	-	-	-	D	-	-	-	-
Enteromorpha ?flexuosa	-	-	O	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromophycota indet. (Fil.)	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-	E	-	-	-	-	-	-
Ulva lactuca	-	-	-	D	-	-	D	-	-	O	-	-	-	-	-	-	O	-	-	-	C	C	-
Chaetomorpha sp.	-	-	-	-	O	-	-	-	-	R	-	-	-	-	-	-	F	-	-	-	-	-	-
Fucus ceranoides	-	-	-	-	P	-	-	-	-	-	R	-	-	-	-	-	-	-	-	O	-	-	-
Ulothrix ?subflaccida	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cystoclonium purpureum	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-
Porphyra umbilicalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	C	-
Cladophora rupestris	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
Blidingia sp.	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
Chondrus crispus	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhodophycota indet. (Fil.)	-	-	-	-	-	-	-	-	-	-	-	O	O	-	-	-	-	-	-	-	-	-	-
ANIMALS																							
Chironomdae	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amphipoda indet.	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hediste diversicolor	-	O	A	C	P	C	O	C	-	C	A	C	C	C	C	C	F	A	E	P	P	-	-
Scrobicularia plana	-	O	-	-	-	O	C	C	-	C	-	F	C	-	-	R	-	C	-	-	-	-	-
Pleuronectidae indet. juv.	-	-	C	-	F	C	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Crangon crangon	-	-	F	-	F	F	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-
Mysidacea indet.	-	-	C	-	P	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyathura carinata	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-
Corophium volutator	-	-	-	-	C	-	C	A	A	A	O	-	C	-	A	-	-	P	-	A	-	-	-
Anguilla anguilla	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carcinus maenas	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pomatoschistus pictus	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-
Arenicola marina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	A
Crepidula fornicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Mytilus edulis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Verruca stroemia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Semibalanus balanoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	F	-
ADDITIONAL DRIFT RECORDS																							
Plocamium cartilagineum	-	-	-	D	D	-	-	D	-	-	-	-	D	-	-	-	D	-	-	-	-	-	-
Gracilaria verrucosa	-	-	-	D	-	D	-	-	-	-	-	-	D	-	-	-	D	-	-	-	-	-	-
Lomentaria clavellosa	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Laminaria spp.	-	-	-	-	D	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Delesseria sanguinea	-	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palmaria palmata	-	-	-	-	D	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-	-	-	-
Cryptopleura ramosa	-	-	-	-	D	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhodophyllis divaricata	-	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acrosorium uncinatum	-	-	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sargassum muticum	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grateloupia sp.	-	-	-	-	-	-	-	-	-	-	D	-	-	-	-	-	-	-	-	-	-	-	-
Callophyllis laciniata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	D	-	-	-	-
Holmsella pachyderma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	D	-	-	-	-	-	-
Hydrallmania falcata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	D	-	-	-	-	-	-

Table 3.

Quantitative infaunal data from intertidal sediments.

(Figures as no.s in 4 x $0.01m^2$ cores, except Sites 14 and 15 where a $0.1m^2$ grab sample was taken at each).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Nematoda indet	103	1	-	1	-	-	-	-	-	-	2	-	-	-	-	1	-	-	-	-	16	8	-
Turbellaria indet.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemertea indet.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
Anaitides mucosa (Oersted)	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hediste diversicolor (Muller)	2	2	73	70	43	13	39	74	65	61	137	34	47	47	66	293	223	52	129	112	299	24	-
Paraonidae indet.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34
Malacoceros fuliginosus (Claparede)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	203	-
Polydora sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Pygospio elegans Claparede	-	3	-	-	-	-	1	-	-	5	-	-	9	1	1	69	30	1	2	-	26	100	-
Spio filicornis (Muller)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Streblospio shrubsolii (Buchanan)	-	8	81	158	106	624	586	394	576	659	743	497	360	589	512	55	38	441	147	11	24	-	-
Capitella capitata (Fabricius)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-
Arenicola marina (L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Alkmaria romijni Horst	-	17	-	-	2	1	1	2	3	1	-	7	24	-	1	-	-	19	-	-	-	-	-
Manayunkia aestuarina (Bourne)	-	-	-	-	-	-	2	24	-	12	134	7	41	1	1	-	-	16	-	2	1	-	-
Oligochaeta indet.	1434	318	2122	325	351	91	771	311	398	150	505	203	198	243	134	10	52	717	245	5	188	122	-
Cladocera indet.	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harpactacoida indet.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Podocopina sp. 1	2	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Podocopina sp. 2	9	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Podocopina sp. 3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leucothoe incisa Robertson	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Bathyporeia pelagica (Bate)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65
Bathyporeia sarsi Watkin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	257
Gammarus ?zaddachi Sexton	53	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gammarus sp.28	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Melita palmata (Montagu)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	-	-
Corophium volutator (Pallas)	9	3	10	-	129	-	76	1557	1610	1042	9	-	41	8	909	11	2	20	121	69	3	12	2
Cyathura carinata (Kroyer)	-	-	13	18	-	40	16	30	3	48	35	30	15	15	-	23	11	16	12	13	1	-	-
Sphaeroma ?rugicauda Leach	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asellus aquaticus (l)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heterotanais oerstedi (Kroyer)	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bodotria pulchella (Sars)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Crangon crangon (L)	-	-	-	-	2	3	2	1	4	3	2	4	3	3	5	3	7	5	2	10	8	-	1
Carcinus maenas (L)	-	-	-	-	-	-	2	-	-	1	2	2	-	-	-	-	-	l -	4	1	-	3	1
Brachyura juvs.	2	-	1	-	-	-	-	-	-	-	5	1	-	-	2	-	2	1	28	2	315	7	-
Caenidae	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aphelocheiridae	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomidae	75	2	1	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	1	-	-
Diptera indet	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera indet	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Hydrobia ulvae (Pennant)	10	1	-	-	-	-	1	7	-	11	1	-	-	-	1	-	-	-	-	17	-	1	-
Scrobicularia plana (da Costa)	-	-	-	-	1	2	2	-	-	-	-	2	1	-	-	-	-	6	-	-	-	-	-
Anguilla anguilla (L)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limanda limanda (L)	1	-	-	-	1	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	2	-
No. individuals	1754	374	2306	574	635	775	1499	2400	2659	1994	1575	788	739	910	1632	465	366	1294	691	242	933	492	363
No. taxa	20	12	10	6	8	8	12	9	7	12	11	11	10	11	10	8	9	11	10	10	13	14	8
Shannon-Wiener function H(s)	1	1	1	2	2	1	2	2	1	2	2	2	2	1	2	2	2	2	2	2	2	2	1

Table 4.

Qualitative dredge data.

	Dredge No. 24	25	26	27	28	29
ANNELIDA						
Harmothoe impar (Johnston)	2	-	-	-	-	-
Sigalion mathildae Audouin & Milne-Edwards	1	-	-	-	-	-
Eteone longa (Fabricius)	1	-	-	-	-	-
Anaitides maculata (L.)	1	-	-	-	-	-
Anaitides mucosa (Oersted)	1	-	-	-	-	-
Eumida sanguinea (Oersted)	5	1	-	-	-	-
Hediste diversicolor (Miller)	-	7	25	48	26	4
Nephtys hombergii Savigny	1	-	-	-	-	-
Eunice sp.	1	-	-	-	-	-
Scoloplos armiger (Muller)	7	-	-	-	-	-
Malacoceros fuliginosus (Claparede)	1	9	-	-	-	-
Polydora sp.	1	-	-	-	-	-
Pygospio elegans Claparede	5	1	7	-	-	1
Spio filicornis (Muller)	1	-	2	-	-	-
Spio martinensis Mesnil	-	2	-	-	-	-
Streblospio shrubsolii (Buchanan)	1	-	53	237	418	54
Chaetozone setosa Malmgren	4	3	-	-	-	-
Pherusa plumosa (Muller)	1	-	-	-	-	-
Capitella capitata (Fabricius)	1	-	56	-	-	-
Notomastus latericeus Sars	1	-	-	-	-	-
Maldanidae indet.	1	-	-	-	-	-
Ampharete baltica Eliason	2	-	-	-	-	-
Lanice conchilega (Pallas)	67	8	-	-	-	-
Oligochaeta indet.	2	2	110	134	352	37
CHELICERATA						
Pycnogonida juv. indet.	1	-	-	-	-	-
CRUSTACEA						
Balanus crenatus Brugiere	-	8	-	-	-	-
Perioculodes longimanus (Bate & Westwood)	2	-	-	-	-	-
Leucothoe incisa Robertson	2	-	-	-	-	-
Atylus swammerdami (Milne-Edwards)	6	-	-	-	-	-
Melita palmata (Montagu)	-	1	-	-	-	-
Microprotopus maculatus Norman	2	-	-	-	-	-
Corophium volutator (Pallas)	2	2	1	-	1	-
Cyathura carinata (Kroyer)	-	-	-	2	8	3
Sphaeroma monodi Bocquet, Hoestlandt & Levi	-	1	-	-	-	-
Crangon crangon (L.)	-	-	-	-	1	-
Carcinus maenas (L.)	1	-	-	2	-	-
Brachyura juv. indet.	30	6	-	-	-	-
MOLLUSCA						
Hydrobia ulvae (Pennant)	-	-	-	1	-	-
Hinia reticulata (L.)	1	-	-	-	-	-
Abra nitida (Muller)	2	-	-	-	-	-
Venerupis senegalensis (Gmelin)	1	-	-	-	-	-

Table 5.

Classification, description and evaluation of the conservation importance of habitats/community types surveyed in Christchurch Harbour during the present study.

Classification	Description	Provisional suggested importance
INTERTIDAL		
1. Hard substrata within the estuary.	Thinly scattered stones on sediment surface and man-made structures or objects. Low diversity biota throughout.	Local
2. Open coast lower shore sediments composed of clean sand.	Low lying current-swept and poorly drained sediments fringing the estuary's channel entrance. Low diversity, but dense populations of Bathyporeia spp. and Arenicola marina.	Local
3. Sheltered estuarine mixed sediments.	Gravelly or sandy deposits just inside the harbour entrance. Low diversity/high density fauna corresponds loosely to a low salinity variant of the ARENICOLA community type.	Local
4. Sheltered fine sediments under brackish-water influence.	The major habitat type, covering the main open area of the harbour. Low diversity/high density fauna corresponding to the SCROBICULARIA community type.	Local
5. Current-swept mixed sediments under fresh or brackish-water influence.	The constricted western arm connecting the main harbour arm with the river confluence at Christchurch. Low diversity fauna of fresh-water and brackish-water species.	Local

Table 5. (Cont.)

Classification	Description	Provisional suggested importance
SUBTIDAL		
1. Offshore infralittoral ironstone bedrock or stable boulders.	Smooth rocks ca. 0.5 km south east of the harbour entrance surrounded by sand plain. Diverse, algal dominated biota.	Regional
2. Offshore infralittoral cobbles and pebbles.	Stable stones embedded in sand. Algal dominated, together with encrusting animals such as barnacles and tubeworms.	Local
3. Offshore clean sandy sediments.	Affected by currents and wave action. Supports a sparse substratum-limited flora, and and epifauna dominated by mobile scavengers. Infauna comparatively rich, with dense patches of *Lanice conchilega*.	Local
4. Estuarine current-swept vertical concrete or metal surfaces and small boulders.	A predominantly man-made habitat with a very low diversity fauna and flora composed of environmentally tolerant species.	Local
5. Estuarine current-swept cobbles and pebbles on sandy sediments.	Unstable habitat with a very low diversity of sessile biota. Dominated by the shore crab *Carcinus maenas*. Infauna of low diversity, with high numbers of estuarine species or taxa.	Local
6. Brackish/estuarine muddy sands.	Channel sediments, and their biota, very similar to the intertidal areas of the main open part of the harbour.	Local

Table 6.

Species of conservation interest in Christchurch Harbour.

Species	Notes	Provisional suggested importance
Callistocythere murrayi Whittaker	Type locality Mother Siller's Channel. Exclusively brackish-water benthic ostracod rarely recorded elsewhere (Pembrokeshire, East Anglia and Arcachon Basin). Its rarity is possibly due to under-recording and its provisional suggested importance may require reassessment.	International
Cytherois stephanidesi Klie	A brackish-water benthic ostracod. A Mediterranean species possibly reaching its northern limits of distribution along the British south coast. Rarely recorded but also possibly understudied.	National
Gammarus insensibilis Stock	This is another species from the Mediterranean, where it occurs in fully marine conditions. It is reaching its northern limit along the British south coast where it is only found in brackish lagoons. It has been found at a number of sites east of the Fleet, as far north as Essex.	Regional

APPENDIX 1

Abundance scales for intertidal species.

1. Live barnacles (except B. perforatus) (record adults, spat, cyprids separately); Littorina neritoides Littorina neglecta

   7 Ex 500 or more per 0.01 m^2, 5+ per cm^2
   6 S 300–499 per 0.01 m^2, 3–4 per cm^2
   5 A 100–299 per 0.01 m^2, 1–2 per cm^2
   4 C 10–99 per 0.01 m^2
   3 F 1–9 per 0.01 m^2
   2 O 1–99 per m^2
   1 R Less than 1 per m^2

2. Balanus perforatus

   7 Ex 300 or more per 0.01 m^2
   6 S 100–299 per 0.01 m^2
   5 A 10–99 per 0.01 m^2
   4 C 1–9 per 0.01 m^2
   3 F 1–9 per 0.1 m^2
   2 O 1–9 per m^2
   1 R Less than 1 per m^2

3. Patella spp. 10 mm+, Littorina Littorea (juv. & adults), Littorina mariae/obtusata (adults), Nucella lapillus (juv., < 3 mm)

   7 Ex 20 or more per 0.1 m^2
   6 S 10–19 per 0.1 m^2
   5 A 5–9 per 0.1 m^2
   4 C 1–4 per 0.1 m^2
   3 F 5–9 per m^2
   2 O 1–4 per m^2
   1 R Less than 1 per m^2

4. Littorina 'saxatilis', Patella < 10 mm, Anurida maritima, Hyale nilssoni and other amphipods, Littorina mariae/obtusata juv.

   7 Ex 50 or more per 0.1 m^2
   6 S 20–49 per 0.1 m^2
   5 A 10–19 per 0.1 m^2
   4 C 5–9 per 0.1 m^2
   3 F 1–4 per 0.1 m^2
   2 O 1–9 per m^2
   1 R Less than 1 per m^2

5. Nucella lapillus (> 3 mm), Gibbula sp. Monodonta lineata, Actinea equina, Idotea granulosa, Carcinus (juv. & recent settlement), Ligia oceanica

   7 Ex 10 or more per 0.1 m^2
   6 S 5–9 per 0.1 m^2
   5 A 1–4 per 0.1 m^2
   4 C 5–9 per m^2, sometimes more
   3 F 1–4 per m^2, locally sometimes more
   2 O Less than 1 per m^2, locally sometimes more
   1 R Always less than 1 per m^2

6. Mytilus edulis, Dendrodoa grossularia

   7 Ex 80% or more cover
   6 S 50–79% cover
   5 A 20–49% cover
   4 C 5–19% cover
   3 F Small patches, 5%, 10+ small individuals per 0.1 m^2, 1 or more large per 0.1 m^2
   2 O 1–9 small per 0.1 m^2, 1–9 large per m^2; no patches except small in crevices
   1 R Less than 1 per m^2

7. Pomatoceros sp.

   5 A 50 or more tubes per 0.01 m^2
   4 C 1–49 tubes per 0.1 m^2
   3 F 1–9 tubes per 0.1m^2
   2 O 1–9 tubes per m^2
   1 R Less than 1 tube per m^2

8. Spirorbinidae

   5 A 5 or more per cm^2 on appropriate substrata; more than 100 per 0.01 m^2 generally
   4 C Patches of 5 or more per cm^2; 1–100 per 0.1 m^2 generally
   3 F Widely scattered small groups; 1–9 per 0.1 m^2 generally
   2 O Widely scattered small groups; less than 1 per 0.1 m^2 generally
   1 R Less than 1 per m^2

9. Sponges, hydroids, Bryozoa

   5 A Present on 20% or more of suitable surfaces
   4 C Present on 5–19% of suitable surfaces
   3 F Scattered patches; < 5% cover
   2 O Small patch or single sprig in 0.1 m^2
   1 R Less than 1 patch over strip; 1 small patch or sprig per 0.1 m^2

10. Flowering plants, lichens, lithothamnia

   7 Ex More than 80% cover
   6 S 50–79% cover
   5 A 20–49% cover
   4 C 1–19% cover
   3 F Large scattered patches
   2 O Widely scattered patches all small
   1 R Only 1 or 2 patches

11. Algae

   7 Ex More than 90% cover
   6 S 60–89% cover
   5 A 30–59% cover
   4 C 5–29% cover
   3 F Less than 5% cover, zone still apparent
   2 O Scattered plants, zone indistinct
   1 R Only 1 or 2 plants

Other animal species: record as percentage cover or approx. numbers within 0.01, 0.1 or 1 m^2

APPENDIX 2

Abundance scales used in subtidal recording.

ANIMALS

1. Large solitary species and colonies. For instance, solitary sponges, *Alcyonium digitatum*, hydroid clumps, large anemones, *Pentapora foliacea*, *Cellepora pumicosa*, echinoderms, large solitary tunicates.

ABUNDANT	One or more per 0.1 m^2.
COMMON	One or more per 1 m^2.
FREQUENT	Less than 1 per m^2 but more than about 20 individuals observed.
OCCASIONAL	About 3-20 observed.
RARE	One or two observed.

2. Small solitary species. For instance, *Grantia compressa*, small anemones, *Caryophyllia smithii*, *Antedon bifida*, small solitary tunicates.

ABUNDANT	One or more per 0.01 m^2.
COMMON	One or more per 0.1 m^2.
FREQUENT	One or more per m^2, scattered patches.
OCCASIONAL	Less than one per m^2, scattered small patches.
RARE	Widely scattered individuals, one or two small patches.

3. Small colonial species and crustose species. For instance, encrusting sponges, *Corynactis viridis*, small hydroids, *Polydora ciliata*, beds of *Mytilus edulis*, barnacles, bryozoa, encrusting tunicates.

ABUNDANT	Large confluent colonies with more than 50% cover. More than 100 per 0.01 m^2.
COMMON	Many small or a few large patches with 10% to 50% cover. One or more per 0.01 m^2.
FREQUENT	Scattered patches less than 10% cover overall. One or more per 0.1 m^2.
OCCCASIONAL	Scattered small patches less than 1% cover overall. One or more per m^2.
RARE	Widely scattered very small patches or individuals. Less than one per m^2.

ALGAE

Kelps.

ABUNDANT	Plants mostly less than 50 cm apart. Difficult to swim between.
COMMON	Plants 50 cm to 1 m apart.
FREQUENT	Plants 1 to 2 m apart. Easy to swim between.
OCCASIONAL	Plants more than 2 m apart, zone still apparent.
RARE	Few plants present.

Foliose or filamentous undergrowth species.

ABUNDANT	More than 20% cover over most of area.
COMMON	Less than 20% cover but many plants present throughout zone.
FREQUENT	Less than 20% cover and distribution patchy or scattered plants present throughout zone.
OCCASIONAL	Scattered plants present.
RARE	Few plants seen in dive.

Kelp stipe flora.

ABUNDANT	Plants dense on most stipes.
COMMON	Plants present on most stipes but not dense.
FREQUENT	Distribution patchy, plants may be dense on some stipes, absent on others.
OCCASIONAL	Few plants on many stipes.
RARE	Few plants seen during dive.

Crustose species.

ABUNDANT	More than 50% cover.
COMMON	More than 20% cover.
FREQUENT	More than 5% cover.
OCCASIONAL	Less than 5% cover. Few scattered large patches or many small patches.
RARE	Few patches seen.