

English Nature Science Series

No 29

**Saline Lagoons and Lagoon-like
Saline Ponds in England**

An update of the lagoons and lagoon-like habitats
recommended for conservation.

P, S, B, JNCC, XX

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A J Downie

Maritime Team
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Saline Lagoons and Saline Ponds

Introduction

In 1992 English Nature published a report on the saline lagoons and lagoon like habitats of England (Smith & Laffoley 1992). This report was the first attempt to produce a directory of information on the saline lagoon resource in England, estimated at some 1215 ha. It was always intended to be a working document hence the inclusion of "1st Edition" as a sub-title.

The current report, therefore, is an attempt to update the information contained in the original directory on those sites identified by Smith & Laffoley (1992) a worthy of conservation. This list of sites was a composite of the true coastal saline lagoons identified by Barnes (1988) and the coastal saline ponds identified by Sheader & Sheader (1989) which together were recommended as being worthy of conservation in the first instance. The remaining 'saline lagoon' resource should not, however, be ignored as all saline lagoons and ponds are relatively fragile and vulnerable habitats. Table 1, therefore, lists the current status of those sites in England deemed to be worthy of conservation. The first thing to notice is that the overall number of sites is less than that cited by Smith & Laffoley (1992). Two sites, Heacham harbour and Horsey Island have been removed from the original list following comments received on the 'working document' and one site King's Marshes included (it is part of the Orford Ness cSAC).

Conservation and Protection

Again no attempt has been made here to answer the question as to whether *species* or *habitat* conservation is the more important, however a distinction is made between naturally formed lagoons and artificially created lagoon-like habitats supporting a similar fauna and flora. The rarity of true lagoons, both on a national and European scale is such that their conservation is of great importance. This is reflected in their priority conservation designation afforded under Annex 1 of the Habitats Directive (CEC 1992). For which a series of Special Areas of Conservation (SACs) have been proposed (see Table 1).

Pye & French (1993) in their report on targets for coastal habitat re-creation suggested that the minimum target for re-creation which should be set to replace likely losses in the next twenty years, should be 120 ha for saline lagoons. Further research was cited as a requirement to define more precisely the environmental requirements of certain key 'lagoon' species. Also it should be noted that the UK Biodiversity steering group report (Anon 1995) has given high priority to the lagoon habitat and some of the lagoonal species by specifically highlighting them through the production of costed action plans at an early stage. This report provides advice to Government on meeting the UK's obligations under the Biodiversity Convention arising from the Rio Earth Summit in 1992. The lagoon costed habitat action plan also recommends that 700 hectares of lagoon habitat be appropriately maintained and improved through to 2010.

A second element of the steering group report was to identify criteria for selecting key species and produce a list to direct work. The initial 'Long list' consisted of some 1250 species, the 'Middle list' of some 400 species and the 'Short list' of some 116. Costed species action plans have also been produced for Ivell's sea anemone *Edwardsia ivelli* and the starlet sea anemone *Nematostella vectensis*, being the saline lagoonal specialist species on the 'Short list of Globally Threatened/Declining Species'. Other saline lagoon specialist species such as the lagoon sandworm *Armandia cirrhosa* and the foxtail stonewort *Lamprothamnium papulosum* appear on the 'Middle list of Globally Threatened/Declining Species'. Whilst yet more, namely the Bembridge water beetle *Paracymus aeneus*, lagoon sand shrimp *Gammarus insensibilis*, two

snails *Hydrobia neglecta* and *Hydrobia ventrosa*, lagoon sea slug *Tenellia adspersa*, trembling sea-mat *Victorella pavida*, tentacled lagoon worm *Alkmaria romijni*, Baltic stonewort *Chara baltica*, convergent stonewort *Chara connivens* and bird's nest stonewort *Tolypella nidifica* all appear on the 'Long list of Globally Threatened/Declining Species'.

Barnes (1988) and Bamber *et al.* (1992) have previously identified a number of specialist saline lagoonal species recorded in Britain (see Table 1 of Smith & Laffoley 1992). Recent developments have shortened this list somewhat and Table 2 lists those species now defined as distinctly more characteristic of lagoon-like habitats than fresh water, estuarine brackish water or the sea, ie excluding those species widely found in brackish ditches or other non-lagoonal habitats (JNCC 1996).

Nine of these species are protected under Schedules of the Wildlife and Countryside Act 1981 (Anon 1981). Of these, Ivell's sea anemone, *Edwardsia ivelli*, is only known from Widewater Lagoon, Sussex and has not been seen since 1983. And the Trembling sea mat *Victorella pavida* is only found in Swanpool lagoon, Cornwall where it has recently been confirmed as part of a mapping project (P. Gainey pers comm.). The lagoon sand worm *Armandia cirrhosa* was originally known only in Eight Acre Pond where it has not been seen since 1987 but has now been found in Portland Harbour and the Fleet Lagoon (Downie 1995 & 1996, Smith 1995).

A thorough understanding of the biology and distribution of both the lagoon resource itself and the specialist organisms which inhabit it is essential, therefore, if lagoons are not to deteriorate and their inhabitants be lost as a result of poor management.

Identification guides

To aid in the identification of these brackish water organisms Barnes (1994) has recently published an identification guide to brackish-water habitats, ecology and macrofauna. Also Covey *et al.* (in prep.) have produced a biotope classification for saline lagoons, resulting in some forty two biotopes. And although based on the work done in Scotland initial indications are that most of the English sites will fit easily into this scheme without the addition of too many more biotopes (R. Covey pers comm.). In addition the recent guidelines for the selection of biological SSSIs for intertidal marine habitats and saline lagoons (JNCC 1996) sets out the manner in which saline lagoons could be selected for protection as part of the SSSI series.

Layout

The data on each lagoon has been presented in the format adopted by the original *Saline Lagoon Directory*. Some lagoons are grouped under a collective or system name where there appears little benefit in subdividing them. Five lagoons at Shingle Street for example are found as one entry. For each site basic information is given on a number of the lagoons physical characteristics. The type/classification section refers to the way in which seawater is thought to enter the lagoon and is based on Sheader & Sheader (1989). For this report lagoons are grouped into one of five classes after JNCC (1996):

1. Saline lagoon inlets

These are saline lagoons where there is a permanent connection with the sea. Any sill which is present is subtidal. Water exchange with the open sea is limited by the restricted nature of the connecting channel, both in terms of width and any subtidal sill. Because of the reduced water exchange, conditions may become brackish due to freshwater input, and a halocline may develop.

2. Isolated saline lagoon

These are pools which are completely isolated from the sea by a barrier of rock or sediment. No seawater enters the pool by percolation, the only input of salt water occurring by limited groundwater seepage, by overtopping of the barrier (sill) on extreme high water spring tides, or by salt water inundation during storms. Because of the limited water exchange, salinity may vary considerably with time.

3. Percolation saline lagoon

These pools are separated from the sea by a permeable barrier of shingle or pebbles and small boulders. Sea water exchange occurring through the barrier to varying degrees dependent on the permeability of the barrier. In highly permeable conditions tidal fluctuation matches that of the open coast and salinity is only marginally reduced from that of the open sea. At the other extreme, there is little fluctuation with rise in level occurring during spring tides and fall in level during neap tides. In these sites salinity may be substantially reduced.

4. Sluiced saline lagoons

These are lagoons where the ingress and egress of water from the lagoon to the open sea is modified by human mechanical interference. This may take the form of a simple pipeline to culvert the water under a road, to a system of valves which restrict water flow as necessary to prevent tidal flooding. Sluiced saline lagoons vary enormously in their physiographic conditions.

5. Silled saline lagoon

These are in many respects similar to some examples of sluiced lagoons. They are generally rocky basins which contain a sill between mean high water or spring tides and mean low water of spring tides. This sill restricts water exchange with the open sea and maintains standing water within the lagoon at all states of the tide.

None of the lagoons featured in this report are an example of class number 5.

Protected status refers to any protection that the lagoon may have, either by virtue of being part of a cSAC (candidate Special Area of Conservation), SSSI (Site of Special Scientific Interest), NNR (National Nature Reserve), LNR (Local Nature Reserve), Ramsar, SPA (Special Protection Area) site, AONB (Area of Outstanding Natural Beauty) or ownership by a trust.

A number of physical parameters are then given. For salinity, a range is given where more than one measurement was taken. Where a single figure is shown it should be remembered that this merely represents one reading taken on a single day. A wide range in salinity values may be expected for most lagoons, both over time, as a result of changing weather conditions and tidal cycles, and over distance, with gradients of salinity existing within a lagoon as a result of point or linear inputs of salt or fresh water. A single value should not, therefore, be taken to imply that the salinity of the lagoon remains constant.

A lagoon description includes, where possible, a physical description of the lagoon and its immediate vicinity, an account of the type and location of any flora and, where possible, a species list. Table 1 details all those lagoons for which a description is included. The table details the conservation status of each site, in particular whether it is within a cSAC or a SSSI and if so, whether the lagoon is mentioned within the citation and thus afforded direct protection.

Note:

The following list of categories will be used to identify those species that fall within these categories, throughout the rest of the report.

- ** Protected by the Wildlife & Countryside Act 1981.
- a In Britain known only from saline lagoon-like habitats.
- b Known only from Widewater, West Sussex.
- c Known only from Swanpool, Cornwall.
- d Non-native marine species in British waters (Eno in prep.)
- e Rare and scarce marine benthic flora and fauna in GB (Sanderson 1996)
- f Specialist species after JNCC (1996)

Table 1. Saline lagoons and lagoon-like saline ponds worthy of conservation

Saline Lagoons

Site name	County	Conservation Status
Cresswell Ponds	Northumberland	SSSI, Wildlife Trust Reserve
Easington Lagoons Protection	N. Humberside	SSSI, pSPA, Ramsar, Area of Special
Snettisham	Norfolk	SSSI, RSPB Reserve
Broad Water	Norfolk	SSSI, cSAC, SPA, Ramsar, Wildlife Trust Reserve, AONB
Holkham Salts Hole Trust Reserve,	Norfolk	SSSI, NNR, cSAC, Ramsar, SPA, Wildlife AONB
Abraham's Bosom	Norfolk	SSSI, cSAC, SPA, Ramsar, AONB
Blakeney Spit Pools	Norfolk	SSSI, cSAC, SPA, Ramsar, Wildlife Trust Reserve, AONB
The Denes	Suffolk	SSSI, NNR, cSAC
Benacre Broad	Suffolk	SSSI, NNR, cSAC
Covehithe Broad	Suffolk	SSSI, NNR, cSAC
King's Marshes (Orford Ness)	Suffolk	SSSI, NNR, cSAC
Shingle Street (Orford Ness)	Suffolk	SSSI, NNR, cSAC
Aldeburgh P8 (Orford Ness)	Suffolk	SSSI, NNR, cSAC
Rye Harbour Lagoon	E. Sussex	SSSI, LNR
Widewater	W. Sussex	SNCI
The Fleet	Dorset	SSSI, cSAC
Swanpool	Cornwall	SSSI, LNR

Saline ponds (lagoon-like habitats)

Killingholme Pools	S. Humberside	pSSSI, Wildlife Trust Reserve
Humberston Fitties Reserve	Lincolnshire	SSSI, NCR Site, SPA, Ramsar, RSPB
Cliffe Marshes	N. Kent	SSSI, pSPA/Ramsar
Pagham lagoons	W. Sussex	SSSI, SPA, LNR
Birdham Pool	W. Sussex	SSSI, cSAC, SPA
Shut Lake	Hampshire	SSSI, cSAC, LNR
Keyhaven-Lymington	Hampshire	SSSI, NNR, cSAC
Gilkicker	Hampshire	SSSI, cSAC
Little Anglesey	Hampshire	None
Bembridge Harbour Lagoon	IoW	SSSI, cSAC
Harbour Farm (Brading Marshes)	IoW	SSSI, cSAC

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Saline Lagoons in England Recommended for Conservation

Cresswell Ponds

Easington Lagoons

Snettisham

Broad Water

Holkham Salts Hole

Abraham's Bosom

Blakeney Spit Pools

The Denes

Benacre Broad

Covehithe Broad

King's Marshes (Orford Ness)

Shingle Street (Orford Ness)

Aldeburgh P8 (Orford Ness)

Rye Harbour Lagoon

Widewater

The Fleet

Swanpool

The lagoons lie within Cresswell Ponds SSSI which covers some 20.2 hectares 49.9 acres. This is one of a series of large shallow ponds which lie behind the coast road and sand dunes at Cresswell. These comprise a large pond which is the only permanent brackish water-lagoon on the Northumberland Coast and two, smaller, freshwater ponds. They are sited in grazed, fixed dune-land and have been formed since 1958 as a result of mining subsidence. Subsequently the pits were used as a municipal rubbish dump. Tipping was halted in 1976 and the site was subsequently landscaped.

SITE NAME:	Cresswell Ponds
LOCATION:	Ashington, Northumberland
GRID REFERENCE:	NZ 283 944
TYPE/CLASSIFICATION:	Sluiced
DESIGNATION:	Cresswell Ponds SSSI, Wildlife Trust Reserve
AREA (ha):	7.75
MAX DEPTH (m):	2.0
SALINITY (‰):	24-26
ADJACENT HABITATS:	Grazed grassland
SURVEY DATE:	August 1986
SURVEYOR:	M Sheader and A Sheader
OTHER SURVEYS:	P Collins, P Dacombe & P Evans 1987, Evans 1993
MANAGEMENT:	Management plan under discussion (English Nature, Northumberland Wildlife Trust)

Lagoon Description

Only one of the ponds is brackish, and has a channel running under the road, through the dunes, to the top of the broad sandy beach of Druridge Bay. The channel is about 3m in width at its narrowest point and is blocked by sand at its seaward end forming an effective sill maintaining the water level in the lagoon. The high salinity indicates that seawater enters the lagoon regularly, probably at most spring tides. There is no obvious freshwater inflow.

The lagoon bottom shelves gradually from the margins and is probably shallow throughout (<1m). The northern section of the lagoon is less than 30cm deep. Sediment within the lagoon varies from soft organic mud at the northern end to muddy sand towards the southern and eastern margins, with clean sand and boulders in the sea channel.

The vegetation of the main pond reflects the saline influence. The aquatic flora is dominated by filamentous algae, beds of *Phragmites* occur as emergent and marginal vegetation along the southern and eastern margins, with *Spergularia marina* along the shallow northern edge. Only two species of macrophyte are present throughout the lagoon, *Enteromorpha* sp and *Cladophora* sp, with mats of blue green algae on the surface of the mud at the shallow northern end. Apart from small amounts of *Enteromorpha* attached to the bridge supports, the sea channel is devoid of attached macro algae, though does receive algal debris at high tide.

The marginal vegetation is similar to that of saltmarshes. Ungrazed areas support sea arrowgrass *Triglochin maritima*, sea aster *Aster tripolium*, sea-milkwort *Glaux maritima*, sea plantain *Plantago maritima*, sea club-rush *Scirpus maritimus* and toad rush *Juncus bufonius*. A close-cropped turf of common saltmarsh grass *Puccinella maritima* and lesser sea-spurry *Spergularia marina* has developed in grazed areas. There are also fragmentary stands of common reed *Phragmites australis*.

Cresswell Ponds are noted for the occurrence of unusual birds on migration and are used as feeding and roosting areas by wintering waders and wildfowl.

The fauna of this relatively new lagoon is moderately diverse, with insects accounting for 60% of species recorded, suggesting that salinity is usually much lower. This was confirmed in a subsequent survey (Collins *et al.* 1987) which found that the lagoon is part of Blakemoor Farm, and a Farm trail, run in conjunction with the Northumberland Naturalists Trust, passes over the northern end of the pond. Bird watching at the site is encouraged.

Species present

oligochaetes
Phragmites australis
Hydrobia ventrosa^{a,f}
Spergularia marina
Mya (empty shells)
Enteromorpha sp.
Gammarus duebeni
Cladophora sp.
Ostracod sp.
Rhizoclonium sp.
Tipulid sp.
Tabanid sp.
Syrphid sp.
Coleoptera
dipteran larva
Lipura sp.
Potamopyrgos antipodarum
Nereis pelagica
Corophium volutator
Sphaeroma rugicaunda
Neomysis integer
Daphnia sp.
Lymnaea sp.
Triglochin maritima
Aster tripolium
Glaux maritima
Plantago maritima
Scirpus maritimus
Juncus bufonius
Puccinella maritima

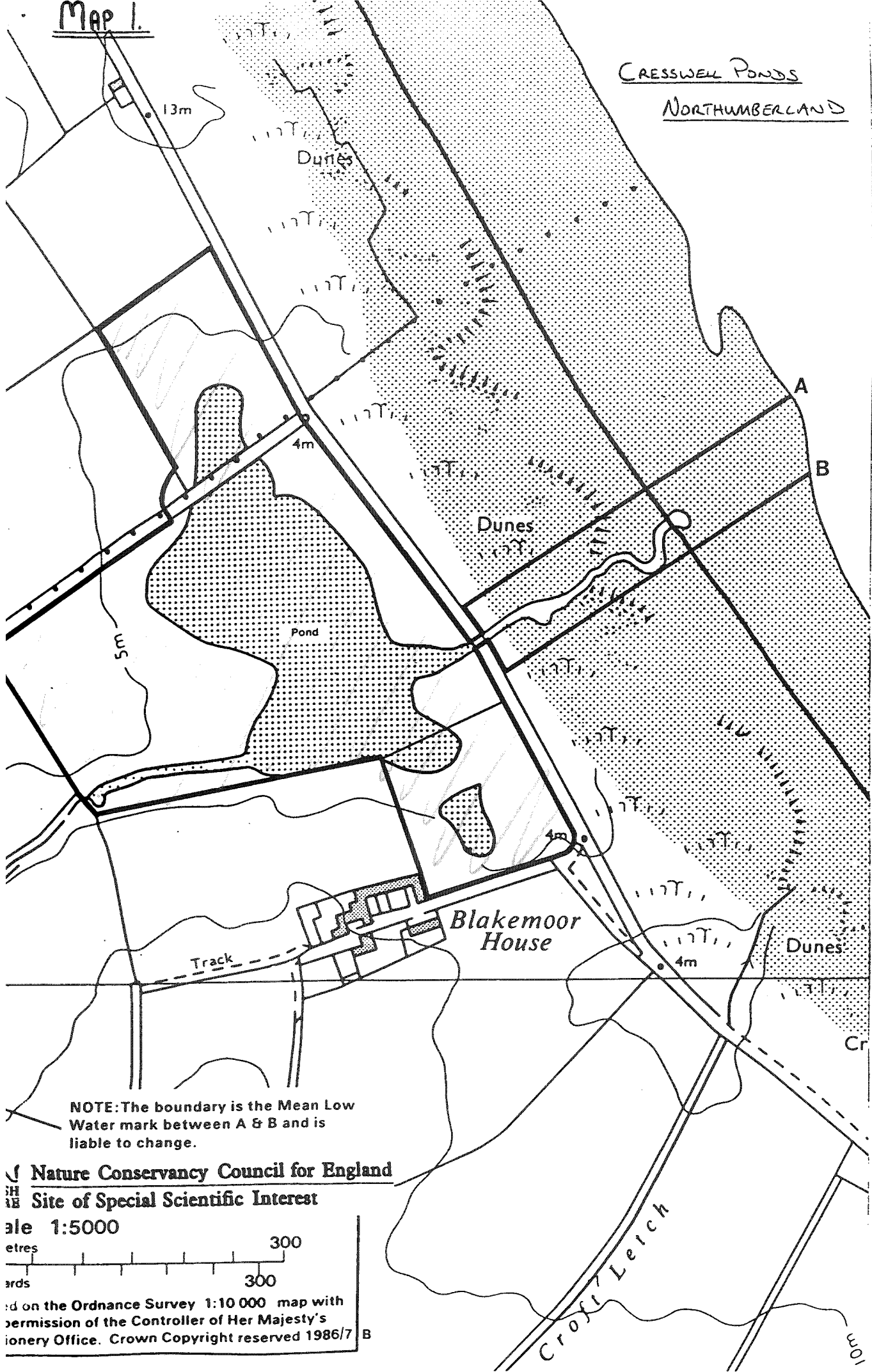
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SHEADER, M. & SHEADER, A. 1986. *Survey of brackish coastal lagoons, Newcastle-upon-Tyne to Berwick-upon-Tweed, 1986: Field Report.* (CSD Report No. 750.). Peterborough: Nature Conservancy Council.

Map 1.

CRESSWELL PONDS
NORTHUMBERLAND



NOTE: The boundary is the Mean Low Water mark between A & B and is liable to change.

Nature Conservancy Council for England
Site of Special Scientific Interest

Scale 1:5000



Based on the Ordnance Survey 1:10 000 map with permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1986/7 B

Data for both Easington Lagoons sites should be considered together since they are in fact one site, namely the Lagoons SSSI. The SSSI is situated on the Holderness coast some 2km north of Spurn peninsula and south west of Easington village. It comprises a variety of coastal habitats including saltmarsh, shingle, sand dune, swamp and most significantly, saline lagoons and pools which represent the only extant example in North Humberside of this nationally rare habitat. Area of the SSSI = 67.9 hectares 167.8 acres. The site overlaps in part with a site known as Spurn Head, a site identified as being of national importance in the Geological Conservation Review. Also the site lies within the Spurn Heritage Coast defined by the Countryside Commission.

SITE NAME:	Easington Lagoons
LOCATION:	Easington, North Humberside
GRID REFERENCE:	TA 410 177
TYPE/CLASSIFICATION:	Isolated
DESIGNATION:	The Lagoons SSSI, pSPA/Ramsar, Area of Special Protection
AREA (ha):	5.6 + 6.5
MAX DEPTH (m):	?
SALINITY (‰):	?
ADJACENT HABITATS:	Saltmarsh, Dunes, Sand/shingle
SURVEY DATE:	1985
SURVEYOR:	M Sheader and A Sheader
MANAGEMENT:	

Lagoon Description

The northern lagoon is bounded by flood banks that to the east, having been breached and overtopped in the 1950's to form the current lagoon. The southern lagoon is formed by tidal inundation of a former borrow pit.

Both northern and southern lagoons support populations of the nationally scarce spiral tasselweed, *Ruppia cirrhosa*^f, together with a range of invertebrate species characteristic of coastal saline habitats. Of these, two crustaceans, *Palaemonetes varians* and *Idotea chelipes*^f, a mollusc *Hydrobia ventrosa*^{a,f} and a bryozoan *Conopeum seurati*^f, are particularly characteristic of such lagoons. The southern lagoon contains a population of silkweed (*Chaetomorpha linum*^f), a filamentous green alga, and this its northern-most lagoonal locality on the east coast of Britain.

Around the lagoon there is a mosaic of saltmarsh and sparsely vegetated sand and saltpan, the extent of the latter being determined by the duration of tidal inundation. Saltmarsh vegetation is dominated by sea aster (*Aster tripolium*), and mud rush (*Juncus gerardii*) with other commonly occurring species including red fescue (*Festuca rubra*), sea arrowgrass (*Triglochin maritima*), sea club-rush (*Scirpus maritimus*), glasswort (*Salicornia europaea*) and buck's-horn plantain (*Plantago coronopus*). Small stands of common reed (*Phragmites australis*) also occur in this vegetation mosaic. Sand dunes at the southern end of the site are dominated by marram grass (*Ammophila arenaria*) and lyme-grass (*Leymus arenarius*).

Of particular importance is the colony of over 1% of the British breeding population of little tern, a rare species which nests on the sand dune and shingle storm beach seaward of the northern lagoon. The other notable species breeding in this habitat is ringed plover.

The lagoons are utilised by a variety of waders on spring and autumn passage, and the area is a noted location for wintering coastal passerines such as shorelark and snow bunting. Sea duck such as goldeneye, scaup and smew also occur on the open water areas in winter.

Tidal inundation is now very regular (D. Leach pers com.) Due to coastal erosion and periodic removal of the shingle ridge. The western edge of the site is bounded by flood defences leading to 'coastal squeeze'. However, farmland to the south is now regularly inundated, particularly during storm conditions. An area of water and sand/shingle has developed here - another lagoon in the making?

SITE NAME:	The Easington Ditch Lagoon
LOCATION:	Easington, North Humberside
GRID REFERENCE:	TA 390 173
TYPE/CLASSIFICATION:	Sluiced
DESIGNATION:	Humber Flats and Marshes: Spurn Head to Salt End Flats
Ramsar AREA (ha):	0.6
MAX DEPTH (m):	>0.5
SALINITY (‰):	13-17
ADJACENT HABITATS:	Agricultural land and <i>Spartina</i> marsh
SURVEY DATE:	August 1985
SURVEYOR:	M Sheader and A Sheader
MANAGEMENT:	

Lagoon Description

There are a series of broad ditches behind the seawall at the mouth of the Humber Estuary extending some 5km along the northern shore between Easington and Welwick. Of these, only the easternmost section (750m long, 8m wide) is brackish.

The lagoon is on the seaward edge of low lying agricultural land from which it is separated by a bank of rough grass with occasional bushes of sea buckthorn. Twelve ditches drain into the lagoon along its northern margin. The seaward bank consists of a strip of rough grassland rising up to the seawall, an earth bank faced with stone approximately 25m to the south of the lagoon. A *Spartina* marsh and mudflats extend several kilometres seawards. A coastal path runs along the seawall.

Seawater enters the lagoon through a wooden sluice, 1m wide, through a pipe (40m long, 80cm wide) from the top of saltmarsh to the western end of the lagoon. Seawater probably flows into the lagoon at most high tides, and a strandline within the lagoon suggests a tidal range of 20-30cm. At the western end a small area of sediment is exposed at low tide.

Twelve drainage ditches, approximately 1m in width run into the lagoon at intervals along its northern margin. These function to drain the surrounding low-lying agricultural land (area about 6-7 km²). Water depth varies between >50cm at the eastern end to about 15cm at the western end (measured at low tide). The sediment consists of very soft mud with occasional large stones. Salinity ranged from 13‰ at the eastern end to 17‰ at the western end with no vertical stratification.

The emergent vegetation consists of clumps of *Phragmites* and *Scirpus maritimus* especially along the northern margin in and around the entrances of the drainage ditches. To the west

of the lagoon a *Phragmites* marsh continues along the line of the ditch lagoon for some 200m behind the seawall. The submerged weed within the lagoon consists of floating mats of *Ulva* with a lesser amount of *Enteromorpha*.

Species present

Ruppia cirrhosa^f
Phragmites australis
Enteromorpha sp.
Ulva sp.
Chaetomorpha linum^f
Aster tripolium
Juncus gerardii
Festuca rubra
Triglochin maritima
Scripus maritimus
Salicornia europaea
Plantago coronopus
Ammophila arenaria
Leymus arenarius
Spartina
Capitella capitata
oligochaetes
Hediste diversicolor
Hydrobia ulvae
Hydrobia ventrosa^{a,f}
Conopeum seurati^f
Sphaeroma rugicauda
Gammarus duebeni
Idotea chelipes^f
Neomysis integer
Palaemonetes varians
Halocladia varians
insect larva

The lagoon is the remaining brackish section of a series of ditches extending 5km behind the seawall. A recently constructed pumphouse and sluice at Skeffing has successfully excluded seawater from the remaining ditches which are now at less than 2‰, with no typically brackish biota. If a similar sluice is constructed for the brackish ditch section, or if this section is connected to the drainage system at Skeffing there would be undoubtedly a shift towards a freshwater biota. The present brackish biota is of moderate diversity and unremarkable.

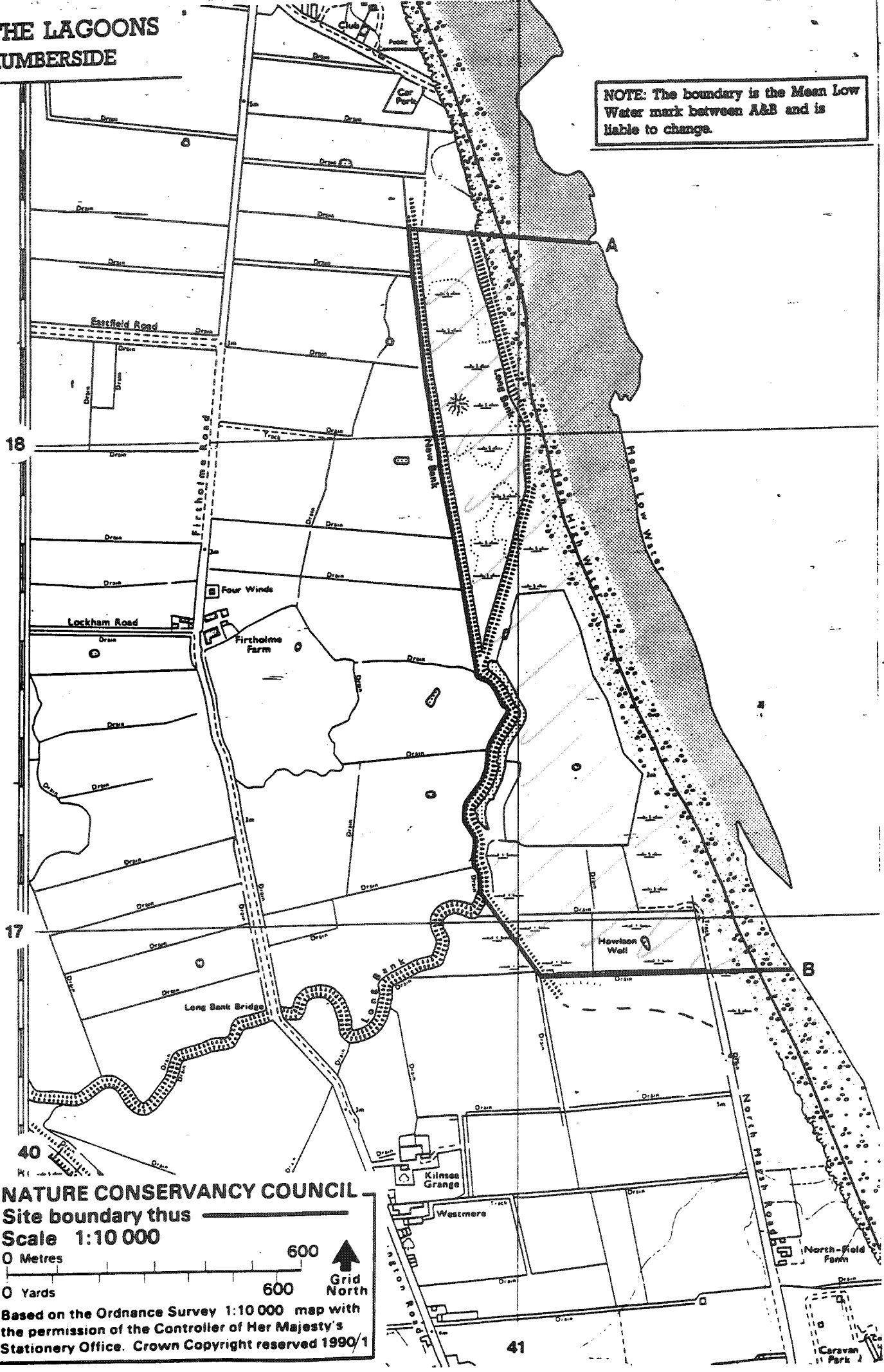
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THE LAGOONS LUMBERSIDE

NOTE: The boundary is the Mean Low Water mark between A&B and is liable to change.



NATURE CONSERVANCY COUNCIL
 Site boundary thus 
 Scale 1:10 000
 0 Metres  600  Grid North
 0 Yards  600
 Based on the Ordnance Survey 1:10 000 map with the permission of the Controller of Her Majesty's Stationery Office. Crown Copyright reserved 1990/1

SITE NAME:	Snettisham Gravel Pits
LOCATION:	Snettisham, Norfolk
GRID REFERENCE:	TF 649 306
TYPE/CLASSIFICATION:	Percolation
DESIGNATION:	The Wash SSSI, RSPB Reserve
AREA:	18.0
MAX DEPTH (m):	(Presumed >2m)
SALINITY (‰):	17-20
ADJACENT HABITATS:	Waste ground
SURVEY DATE:	September 1984
SURVEYOR:	R S K Barnes
MANAGEMENT:	

Lagoon Description

This lagoon (see Map 3 which is taken from Barnes (1984)) has been created by the percolation of water into a disused gravel pit. There is no input of freshwater other than rainwater. Seawater influx is by percolation through the shingle barrier to seaward. Overtopping of the wall at high tides during storms is thought to be another significant source of saltwater.

The sediment is shingle with a superficial covering of silt. Very little emergent vegetation was present (some *Phragmites*) and there were no submerged macrophytes.

Species present

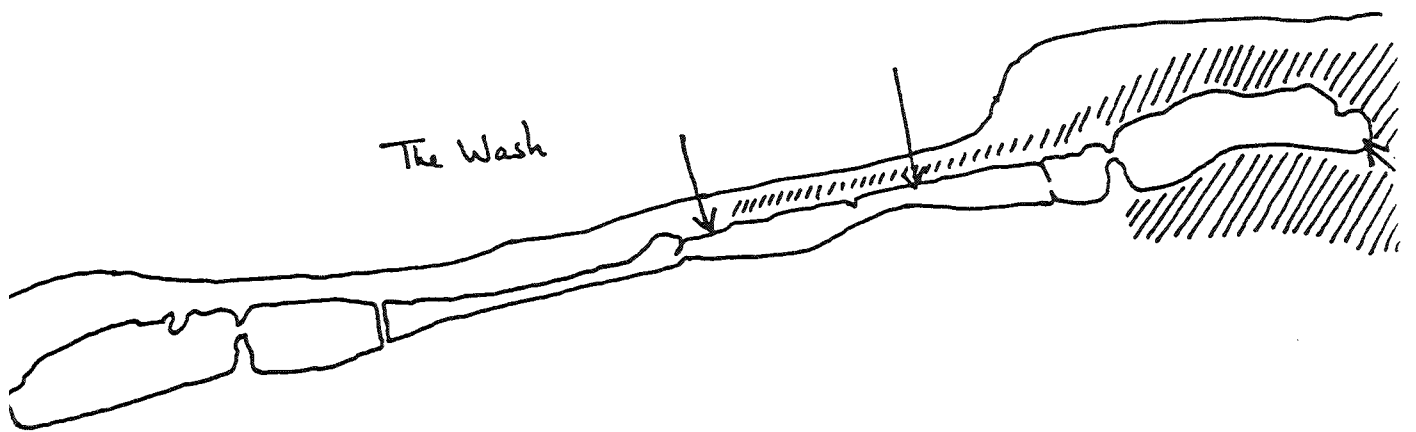
Arenicola marina
Phragmites australis
Idotea chelipes^f
Hydrobia neglecta^{a,f}
Pomatoschistus microps
Cyathura carinata
Praunus flexuosus

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- BARNES, R.S.K. 1987. Coastal lagoons of East Anglia, U.K. *Journal of Coastal Research*, 3(4) 417-427.

SNETTISHAM GRAVEL PITS

→ N.



////// caravan or beach villa site
→ sampling site

Taken from University of Cambridge, Committee for Aerial
Photography photograph RCP-DK 16.
Scale 1:14,000 Date 12 May 1980.

SITE NAME: Broad Water

LOCATION: Holme, Norfolk

GRID REFERENCE: TF 712 446

TYPE/CLASSIFICATION: Percolation

DESIGNATION: North Norfolk Coast SSSI, cSAC, Norfolk NT Reserve and Norfolk Ornithologists Association, AONB, Ramsar, SPA

AREA: 4.4

MAX DEPTH (m): 0.5

SALINITY (‰): 20

ADJACENT HABITATS: Freshwater marsh, dunes and grazing farmland

SURVEY DATE: September 1984

SURVEYOR: R S K Barnes

MANAGEMENT:

Lagoon Description

This large, shallow lagoon (see Map 4 which is taken from Barnes (1984)) is dominated by *Phragmites* which, it is estimated, occupy 55% of the total area. There was once an inflow of both seawater and freshwater via the River Hun, however sluicing has now stopped this.

The lagoon is thought to be partly artificial having been once part of a saltmarsh creek system. No submerged macrophytes were observed. The substrate was sand and soft silt.

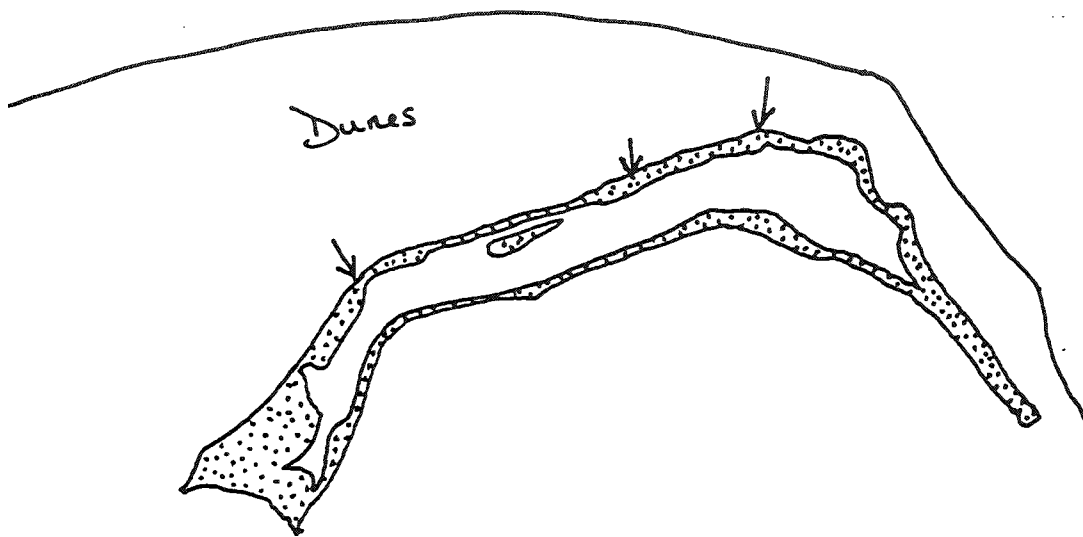
Species present

Hediste diversicolor
Scirpus maritimus
Idotea chelipes^f
Phragmites australis
Gammarus duebeni
Neomysis integer
Palaemonetes varians
Hydrobia ventrosa^{a,f} (dead shells only)
Hydrobia ulvae
Corophium volutator
Sigara spp.

References

- BARNES, R.S.K. 1985. *The coastal lagoons of East Anglia, U.K.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.
- BARNES, R.S.K. 1984. *The coastal lagoons of East Anglia, U.K. Field survey record sheets.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.
- BARNES, R.S.K. 1987. Coastal lagoons of East Anglia, U.K. *Journal of Coastal Research*, 3(4) 417-427.

BROAD WATER



⋯ mud beds
→ sampling sites

Taken from University of Cambridge, Committee for
Aerial Photography, photograph RC8-DK 17.
Scale 1:6,500. Date 12 May 1980

SITE NAME:	Holkham Salts Hole
LOCATION:	Holkham, Norfolk
GRID REFERENCE:	TF 886 451
TYPE/CLASSIFICATION:	Percolation
DESIGNATION:	North Norfolk Coast SSSI and NNR, cSAC, Norfolk NT Reserve, AONB, Ramsar, SPA.
AREA:	0.6
MAX DEPTH (m):	2.8
SALINITY (‰):	24
ADJACENT HABITATS:	?
SURVEY DATE:	September 1984
SURVEYOR:	R S K Barnes
MANAGEMENT:	

Lagoon Description

The lagoon (see Map 5 which is taken from Barnes (1984)) was once part of a saltmarsh creek system before reclamation of the Holkham Marshes. Seawater enters by way of springs. The substrate was sand with the reducing layer at a depth of more than 5cm.

Species present

Ruppia cirrhosa^f
Phragmites australis
Pygospio elegans
Juncus maritimus
Arenicola marina
Hediste diversicolor
Hydrobia ulvae
Littorina saxatilis
Cerastoderma glaucum^{a,f}
Corophium volutator
Gammarus duebeni
Idotea chelipes^f
Sphaeroma rugicauda
Praunus flexuosus
Palaemonetes varians
Pomatoschistus microps

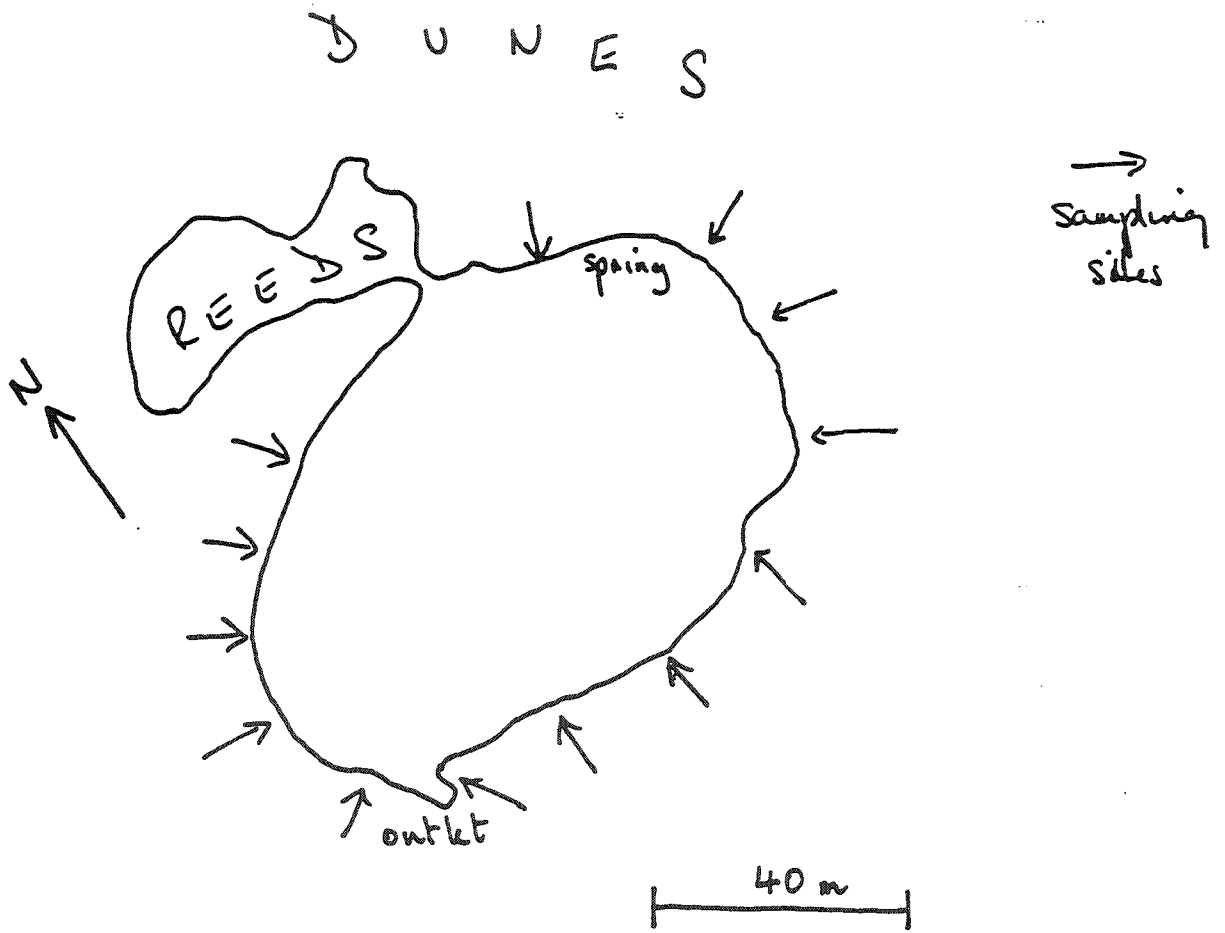
References

- BARNES, R.S.K. 1985. *The coastal lagoons of East Anglia, U.K.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.
- BARNES, R.S.K. 1984. *The coastal lagoons of East Anglia, U.K. Field survey record sheets.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.
- BARNES, R.S.K. 1987. Coastal lagoons of East Anglia, U.K. *Journal of Coastal Research*, 3(4) 417-427.

HUNT, O.D. 1971. Holkham Salts Hole, an isolated salt-water pond with relict features. An account based on studies by the late C.F.A. Pantin. *Journal of the Marine Biological Association of the United Kingdom*, 51: 717-741.

WILLIAMS, R.B., & BEALE, C.J. 1977. A note on Holkham Lake, Norfolk. *Transactions of the Norfolk and Norwich Naturalists' Society*, 24: 83-84.

HOLKHAM SALTS HOLE



From Hunt: *Q. mar. bid. Ass. U.K.*,
51, 717-741 (1971)

SITE NAME:	Abraham's Bosom
LOCATION:	Wells, Norfolk
GRID REFERENCE:	TF 912 452
TYPE/CLASSIFICATION:	Percolation
DESIGNATION:	North Norfolk Coast SSSI, cSAC, AONB, Ramsar & SPA
AREA:	1.6
MAX DEPTH (m):	?
SALINITY (‰):	28-29
ADJACENT HABITATS:	Sand dunes, freshwater marsh
SURVEY DATE:	September 1984
SURVEYOR:	R S K Barnes
MANAGEMENT:	

Lagoon Description

The north end (see Map 6 which is taken from Barnes (1984)) was heavily polluted and anoxic to the surface with much dead and rotting green algae. The middle region was covered with a blanket of living and dead *Enteromorpha*. The south east corner near the outlet was healthy with abundant *Cerastoderma glaucum*^{a,f} and various other organisms. The reducing layer at the south end was at a depth of 1.5cm.

The sediment was soft silt and plant debris at the polluted north end and sand at the south.

Phragmites was present on the western side of the lagoon but very few submerged macrophytes were observed.

Species present

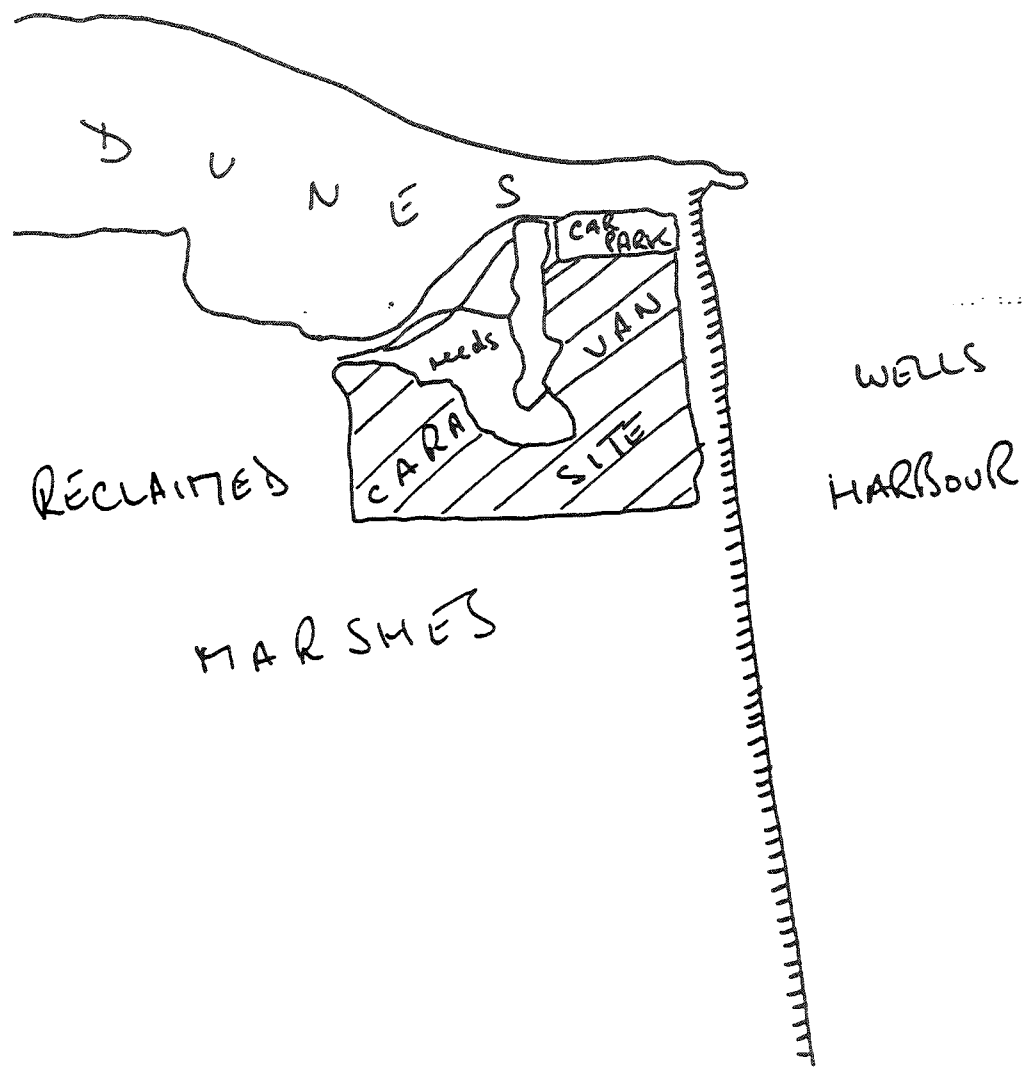
Phragmites australis
Lineus gesserensis
Zostera marina
Enteromorpha sp.
Scoloplos armiger
Arenicola marina
Tubificoides benedii
Retusa obtusa
Cerastoderma glaucum^{a,f}
Abra tenuis
Praunus flexuosus
Pomatoschistus microps

References

- BARNES, R.S.K. 1985. *The coastal lagoons of East Anglia, U.K.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.
- BARNES, R.S.K. 1984. *The coastal lagoons of East Anglia, U.K. Field survey record sheets.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.
- BARNES, R.S.K. 1987. Coastal lagoons of East Anglia, U.K. *Journal of Coastal Research*, 3(4) 417-427.

WILLIAMS, R.B. 1973. The significance of saline lagoons for rare species. *Transactions of the Norfolk and Norwich Naturalists' Society*, 22 (6): 387-392

ABRAHAM'S BOSOM



from University of Cambridge, Committee for Aerial
Photography photograph RC8-GS 123.

Scale 1 : 13,000 . Date 15 January 84

SITE NAME:	Blakeney Spit Pools: Half Moon Pond
LOCATION:	Cley-next-the-Sea, Norfolk
GRID REFERENCE:	TG 049 453
TYPE/CLASSIFICATION:	Percolation
DESIGNATION:	N Norfolk Coast SSSI, cSAC, Wildlife Trust Reserve AONB, Ramsar & SPA
AREA:	0.4
MAX DEPTH (m):	<1
SALINITY (‰):	6
ADJACENT HABITATS:	Shingle
SURVEY DATE:	September 84
SURVEYOR:	R S K Barnes
MANAGEMENT:	

Lagoon description

Half Moon Pond, together with Arnold's Marsh Lagoon, Salthouse Broad, Little Eye, Western and Eastern Gaborough Hill Lagoons, make up a lagoon system collectively known as Blakeney Spit Pools (see Map 7 which is taken from Barnes (1984)).

The pool is found between a shingle ridge and artificial banks enclosing reclaimed marsh. There is no visible freshwater input other than from rainwater and seawater is thought to enter by percolating through the shingle bank.

The bottom substrate is shingle overlain in areas by soft mud. No fringing vegetation was apparent.

Species present

Hediste diversicolor
Ruppia cirrhosa^f
Enteromorpha sp.
Gammarus duebeni
Neomysis integer
Sigara stagnalis

SITE NAME: Blakeney Spit Pools: Arnold's Marsh Lagoon

LOCATION: Salthouse, Norfolk

GRID REFERENCE: TG 062 448

TYPE/CLASSIFICATION: Percolation

DESIGNATION: N Norfolk Coast SSSI, cSAC, Wildlife Trust Reserve, AONB, Ramsar and SPA

AREA: 3.4

MAX DEPTH (m): 0.4

SALINITY (‰): 29

ADJACENT HABITATS: Shingle, reclaimed marsh

SURVEY DATE: September 1984

SURVEYOR: R S K Barnes

MANAGEMENT:

Lagoon description

The lagoon is enclosed between the shingle ridge and artificial banks around reclaimed marshland. Substratum was mud over a stiff clay. Saltmarsh vegetation extends well out into the lagoon in places. The substratum was soft silt and the depth of reduced layer 2-3mm.

No swimming organisms were found in contrast to most of the other lagoons behind the same shingle ridge. The lagoon appears relatively barren faunistically.

Species present

Enteromorpha sp.
Hediste diversicolor
Arenicola marina
Pygospio elegans
Abra tenuis
Corophium volutator

SITE NAME:	Blakeney Spit Pools: Salthouse Broad
LOCATION:	Salthouse, Norfolk
GRID REFERENCE:	TG 068 446
TYPE/CLASSIFICATION:	Percolation
DESIGNATION:	N Norfolk Coast SSSI, cSAC, Ramsar & SPA
AREA:	4
MAX DEPTH (m):	<1
SALINITY (‰):	29-31
ADJACENT HABITATS:	Freshwater marsh
SURVEY DATE:	September 1984
SURVEYOR:	R S K Barnes
MANAGEMENT:	

Lagoon Description

A large, shallow, flight pond floored by soft mud over hard clay demonstrated by a large, freshwater reedswamp to the south and with shingle to the north. The reduced layer is at 2cm and very little emergent vegetation was present. The lagoon mysid, *Paramysis nouveli*, is a nationally rare species.

Species present

Sagartia troglodytes
Phragmites australis
Lineus gesserensis
Enteromorpha sp.
 Blue-green algal 'turf'
Pygospio elegans
Arenicola marina
Hediste diversicolor
Hydrobia ventrosa^{a,f}
Abra tenuis
Corophium volutator
Jaera albifrons (agg.)
Idotea chelipes^f
Paramysis nouveli
Electra crustulenta

SITE NAME:	Blakeney Spit Pools: Little Eye
LOCATION:	Salthouse, Norfolk
GRID REFERENCE:	TG 078 444
TYPE/CLASSIFICATION:	Percolation
DESIGNATION:	N Norfolk Coast SSSI, cSAC, Wildlife Trust Reserve
AREA:	0.5
MAX DEPTH (m):	0.4
SALINITY (‰):	32-33
ADJACENT HABITATS:	Grazing farmland and shingle
SURVEY DATE:	September 1984
SURVEYOR:	R S K Barnes
MANAGEMENT:	

Lagoon Description

A small lagoon similar to Arnold's Marsh Lagoon and Salthouse Broad, although the reduced layer is very deep. The only source of freshwater appeared to be by direct rainfall with seawater entering by percolation. The bottom substrate was soft silt. The only emergent vegetation was *Salicornia*. The lagoons mysid, *Paramysis nouveli*, is a nationally rare species.

Species present

Salicornia sp.
Enteromorpha sp.
Abra tenuis
Pygospio elegans
Corophium volutator
Gammarus locusta
Idotea chelipes^f
Paramysis nouveli
Hediste diversicolor
Arenicola marina

SITE NAME: Blakeney Spit Pools: Western Gramborough Hill Lagoon

LOCATION: Salthouse, Norfolk

GRID REFERENCE: TG 083 442

TYPE/CLASSIFICATION: Percolation

DESIGNATION: N Norfolk Coast SSSI, cSAC, Wildlife Trust Reserve, Ramsar, SPA

AREA: 0.2

MAX DEPTH (m): 0.25

SALINITY (‰): 26-27

ADJACENT HABITATS: Saltmarsh, shingle

SURVEY DATE: September 1984

SURVEYOR: R S K Barnes

MANAGEMENT:

Lagoon Description

A small lagoon floored by shingle with patchy accumulations of soft silt above it. *Corophium* and *Hediste* were confined to these areas. Natural in origin direct rainfall is considered the main source of freshwater.

Species present

Spartina sp.
Hydrobia ventrosa^{a,t}
Corophium volutator
Idotea chelipes^t
Palaemonetes varians
Hediste diversicolor

SITE NAME:	Blakeney Spit Pools: Eastern Gramborough Hill Lagoon
LOCATION:	Salthouse, Norfolk
GRID REFERENCE:	TG 087 442
TYPE/CLASSIFICATION:	Unknown
DESIGNATION:	N Norfolk Coast SSSI, cSAC, Wildlife Trust Reserve, AONB, Ramsar, SPA
AREA:	0.25
MAX DEPTH (m):	0.25
SALINITY (‰):	17-18
ADJACENT HABITATS:	Grazing farmland
SURVEY DATE:	September 1984
SURVEYOR:	R S K Barnes
MANAGEMENT:	

Lagoon Description

This small lagoon is well inland of the shingle ridge and appears to be a remnant of the creek which drained Gramborough Hill Marshes prior to reclamation. *Phragmites* reeds are encroaching on the open water that remains. The bottom substrate is a very soft silt and the *Potamogeton* are covered in a layer. The reduced layer is at a depth of 5cm.

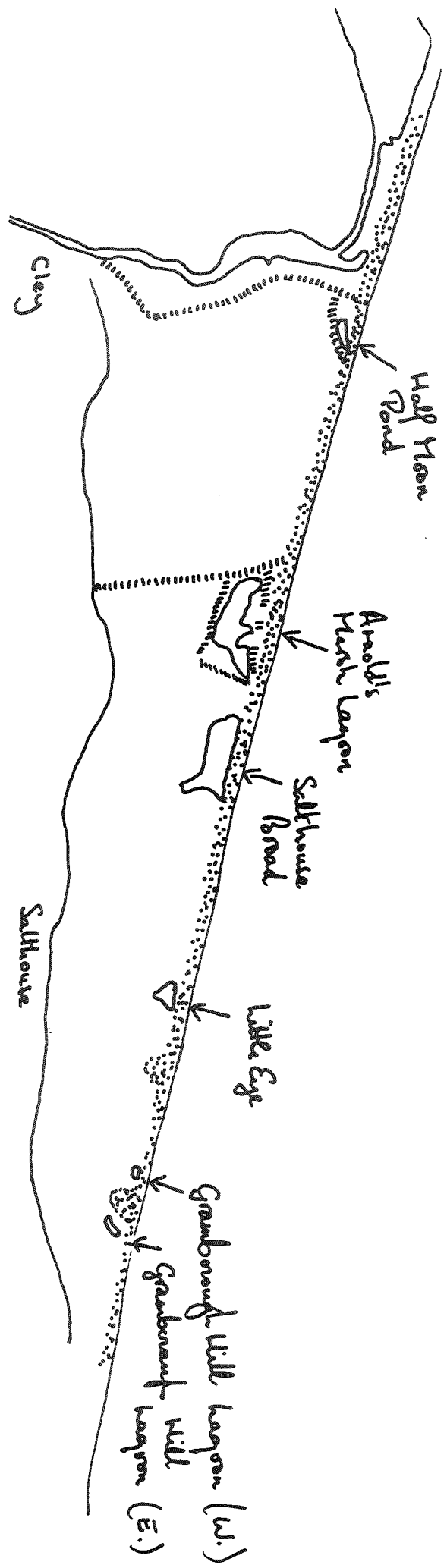
Species present

Phragmites australis
Scirpus maritimus
Hediste diversicolor
Idotea chelipes^f
Corophium volutator
Gammarus duebeni
Potamogeton pectinalis
Hydrobia ventrosa^{a,f} (dead shells only)

References

- BARNES, R.S.K. 1987. Coastal lagoons of East Anglia, U.K. *Journal of Coastal Research*, 3(4) 417-427.
- BARNES, R.S.K. 1985. *The coastal lagoons of East Anglia, U.K.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.
- BARNES, R.S.K. 1984. *The coastal lagoons of East Anglia, U.K. Field survey record sheets.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.

CLEY, SALTHOUSE & GRAMBROUGH HILL LAGONS



..... Shingle ledges
===== Sea walls

Scale 1 : 25,000

SITE NAME:	North West Pool, The Denes
LOCATION:	Benacre, Suffolk
GRID REFERENCE:	TM 535 842
TYPE/CLASSIFICATION:	Percolation
DESIGNATION:	Benacre to Easton Bavents SSSI, Benacre Broad NNR, Benacre-Easton Bavents cSAC
AREA (ha):	1.5
MAX DEPTH (m):	>1.5
SALINITY (‰):	4-5
ADJACENT HABITATS:	Freshwater marsh and shingle
SURVEY DATE:	June 1985
SURVEYOR:	R S K Barnes
MANAGEMENT:	

Lagoon Description

This pool is in an old gravel pit thought to date back to WW II. It is separated from the sea by a shingle bar and another gravel pit. The substratum was shingle with a covering of plant debris. Fringing vegetation was *Phragmites* reed swamp and shingle flora. There were very little submerged macrophytes. Seawater is thought to enter by percolating first into the adjacent North East Pool and from there through the shingle divide. Direct rainfall appeared the only source of freshwater.

Species present

Phragmites australis
Ruppia cirrhosa^f
Idotea chelipes^f
Sphaeroma hookeri^f
Gammarus duebeni
Gammarus zaddachi
Pomatoschistus microps
Hediste diversicolor

SITE NAME:	North East Pool, The Denes
LOCATION:	Benacre, Suffolk
GRID REFERENCE:	TM 536 840
TYPE/CLASSIFICATION:	Percolation
DESIGNATION:	Benacre to Easton Bavents SSSI, Benacre Broad NNR, Benacre-Eaton Bavents cSAC
AREA (ha):	2
MAX DEPTH (m):	1
SALINITY (‰):	24
ADJACENT HABITATS:	Shingle
SURVEY DATE:	June 1985
SURVEYOR:	R S K Barnes
MANAGEMENT:	

Lagoon Description

This pool lies immediately east of the North West Pool and is also thought to date from WW II. Saline input is thought to be through a combination of percolation and overtopping. Substrate was shingle sand and soft silt with the reduced layer down to a depth of 10cm.

Species present

Enteromorpha sp.
Cladophora sp.
Ulva sp.
Hediste diversicolor
Arenicola marina
Pygospio elegans
Idotea chelipes^f
Corophium volutator
Lineus ruber
Amphiporus lactifloreus
Mya arenaria
Gasterosteus aculeatus

SITE NAME:	South Pool, The Denes
LOCATION:	Benacre, Suffolk
GRID REFERENCE:	TM 536 837
TYPE/CLASSIFICATION:	Percolation
DESIGNATION:	Benacre to Easton Bavents SSSI, Benacre Broad NNR, Benacre-Easton Bavents cSAC
AREA (ha):	0.3
MAX DEPTH (m):	>1.5
SALINITY (‰):	30
ADJACENT HABITATS:	Shingle
SURVEY DATE:	June 1985
SURVEYOR:	R S K Barnes
MANAGEMENT:	

Lagoon Description

The smallest of the three gravel pits at The Denes, this lagoon receives seawater by percolation and overtopping of the shingle barrier.

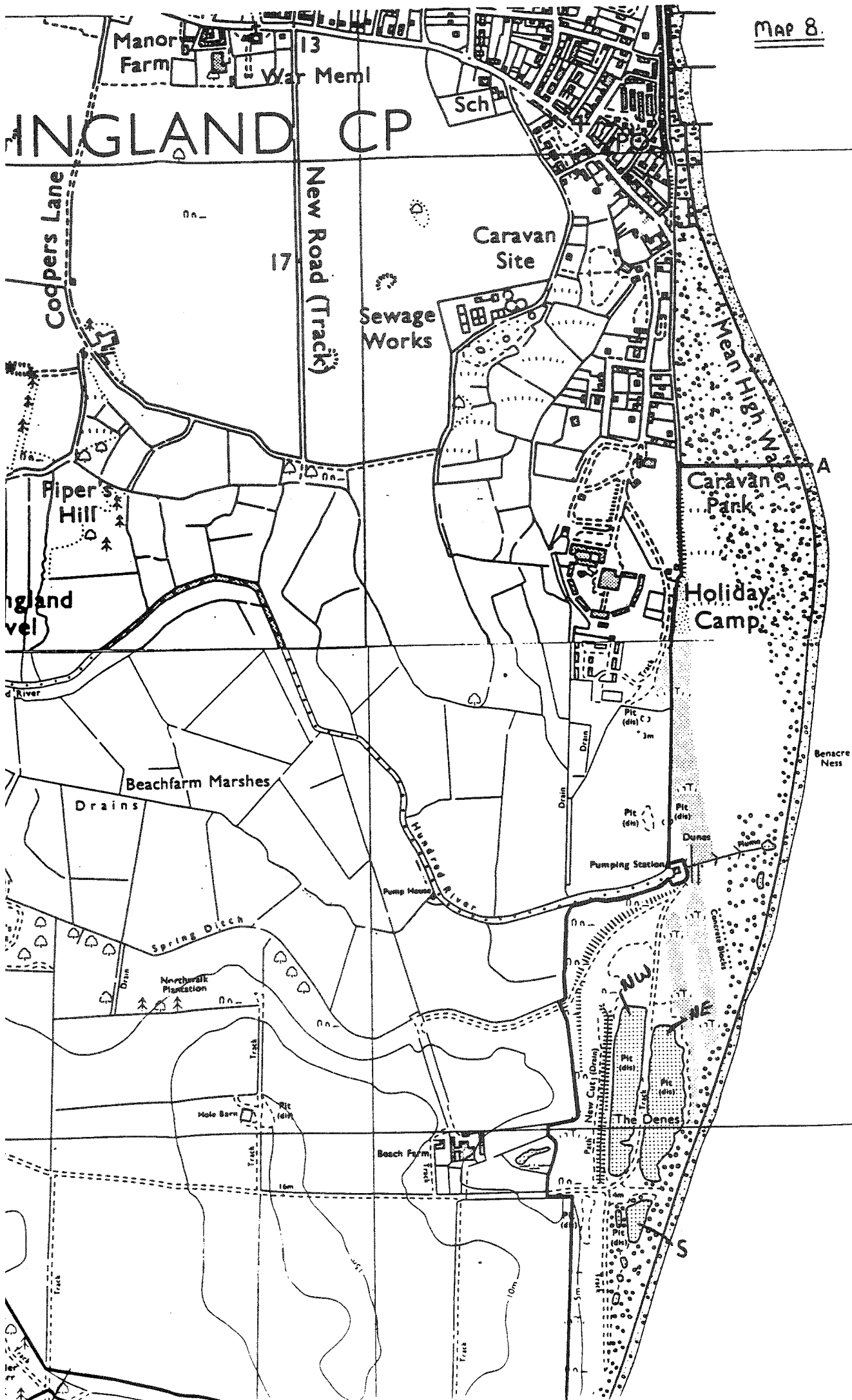
The substrate was shingle covered.

Species present

Zostera angutifolia
Cladophora sp.
Neomysis integer
Palaemonetes varians
Lineus ruber
Arenicola marina
Tubificoides benedii
Pygospio elegans
Melita palmata
Carcinus maenas

References

- BARNES, R.S.K. 1987. Coastal lagoons of East Anglia, U.K. *Journal of Coastal Research*, 3(4) 417-427.
- BARNES, R.S.K. 1985. *The coastal lagoons of East Anglia, U.K.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.
- BARNES, R.S.K. 1984. *The coastal lagoons of East Anglia, U.K. Field survey record sheets.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.



SITE NAME:	Benacre Broad
LOCATION:	Benacre, Suffolk
GRID REFERENCE:	TM 532 828
TYPE/CLASSIFICATION:	Isolated
DESIGNATION:	Benacre to Easton Bavents SSSI, Benacre Broad NNR, Benacre-Easton Bavents cSAC
AREA (ha):	8
MAX DEPTH (m):	?
SALINITY (‰):	6-7
ADJACENT HABITATS:	Freshwater Marsh
SURVEY DATE:	July 1985
SURVEYOR:	R S K Barnes
MANAGEMENT:	

Lagoon Description

The site (see Map 9, which is taken from Barnes (1984) and Map 10, which is taken from the cSAC citation) probably originated as a bay which was subsequently blocked by a sand and shingle bar. Only the eastern margin was visited as the remainder is fringed by dense reedbeds making access impossible without a boat. The lagoon is at a high level relative to the sea (about MHWS). Freshwater is supplied by an inflowing stream and saltwater by overlapping of the bar. The substrate was shingle covered with sand and silt. The depth of the reduced layer was greater than 10cm.

Benacre Broad has suffered recently, 1995/96, from shingle movement (R. Cottle pers comm.). The shingle barrier was breached repeatedly in 1995-1996 and the lagoon has been reduced in size. Therefore, in the autumn of 1996 English Nature, under its habitat action programme for the Biodiversity Action Plan, began a programme of constructing a suite of new lagoons inland of the original lagoon to try and preserve the interest of the site. A single shallow lagoon of approx 20 ha, with 5 separate deep pools within it, has been dug to allow for new lagoon habitat to be present throughout the year (R. Cottle pers comm.)

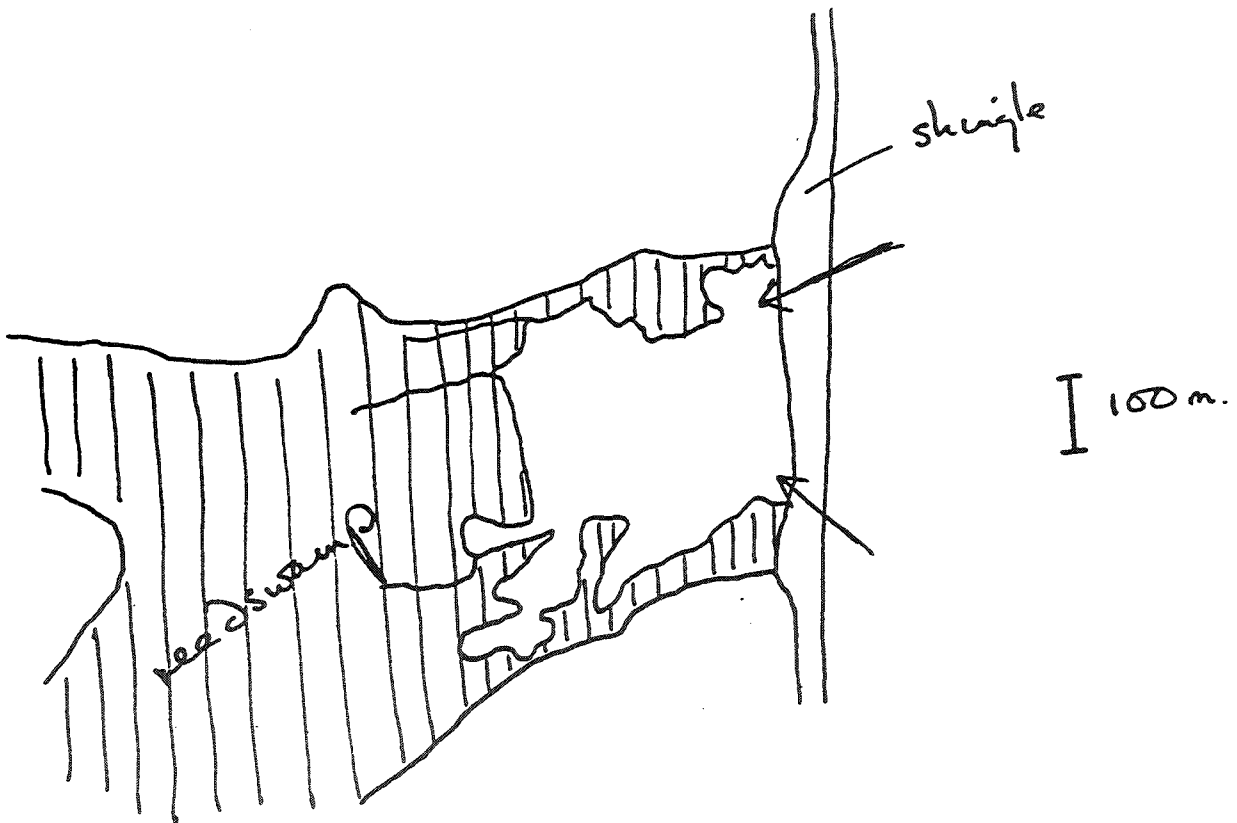
Species present

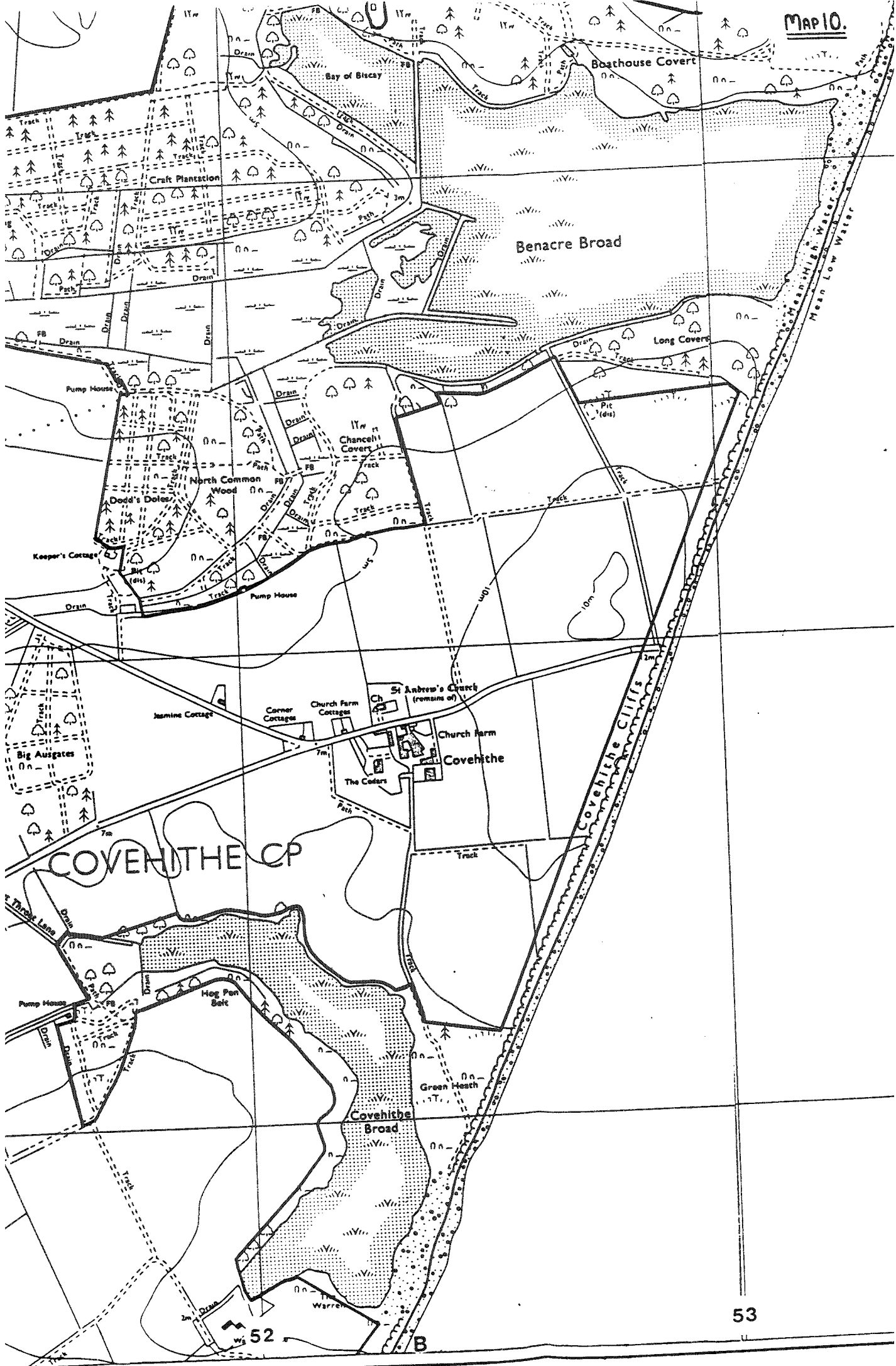
Phragmites australis
Gammarus salinus
Gammarus zaddachi
Neomysis integer
Palaemonetes varians
Cordylophora caspia
Sphaeroma hookeri[†]
Corophium volutator
Corophium arenarium
Notonecta glauca
Sigara coneinna
Conopeum seurati[†]
Gasterosteus aculeatus

References

- BARNES, R.S.K. 1987. Coastal lagoons of East Anglia, U.K. *Journal of Coastal Research*, 3(4) 417-427.
- BARNES, R.S.K. 1985. *The coastal lagoons of East Anglia, U.K.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.
- BARNES, R.S.K. 1984. *The coastal lagoons of East Anglia, U.K. Field survey record sheets.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.

Benacre Broad (from aerial photograph
RC8 CQ 110 Univ. Camb.)





SITE NAME: Covehithe Broad

LOCATION: Covehithe, Suffolk

GRID REFERENCE: TM 523 808

TYPE/CLASSIFICATION: Isolated

DESIGNATION: Benacre to Easton Bavents SSSI, Benacre Broad NNR,
Benacre-Easton Bavents cSAC

AREA (ha): 0.5

MAX DEPTH (m): 1.0

SALINITY (‰): 11-12

ADJACENT HABITATS: Freshwater Marsh

SURVEY DATE: June 1985

SURVEYOR: R S K Barnes

MANAGEMENT:

Lagoon Description

This lagoon (see Map 11, which is taken from Barnes (1984) and Map 12, which is taken from the cSAC citation) probably originated as a result of damming of a bay by a shingle bar. It is being continuously reduced in area as a result of coastal erosion and is likely to disappear. Saline input is by overtopping of the shingle var and freshwater enters via a stream accounting for why the water level is approximately MHWS. The reducing layer was at 10cm.

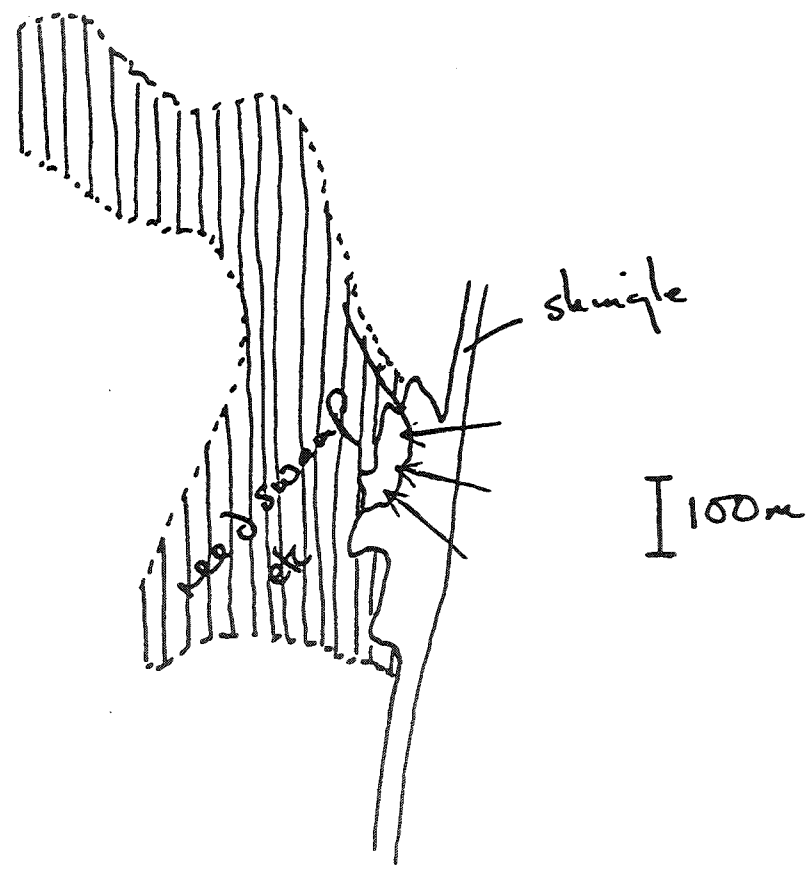
Species present

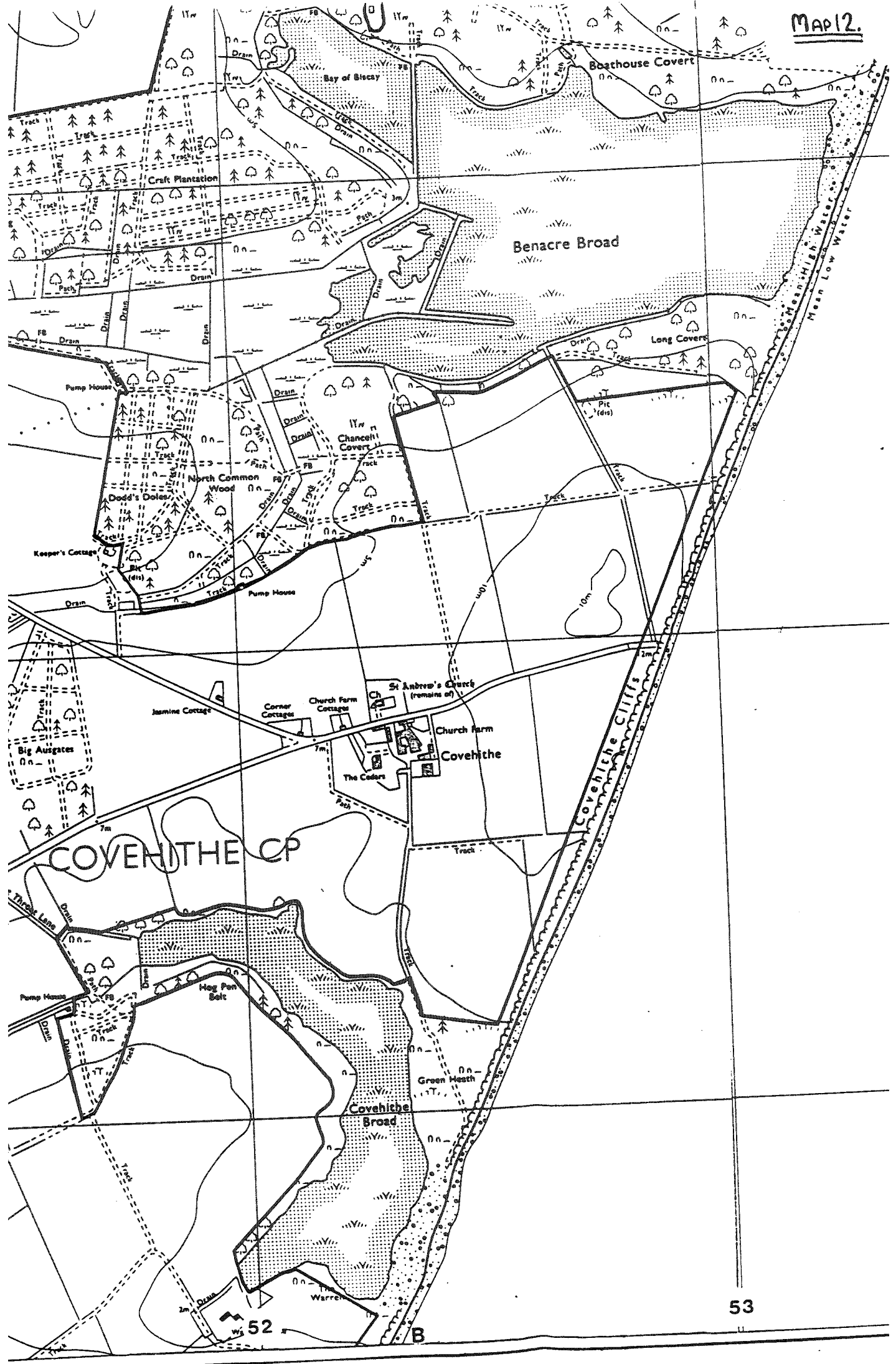
Phragmites australis
Hediste diversicolor
Gammarus duebeni
Neomysis integer
Pomatoschistus microps
Corophium arenarium

References

- BARNES, R.S.K. 1987. Coastal lagoons of East Anglia, U.K. *Journal of Coastal Research*, 3(4) 417-427.
- BARNES, R.S.K. 1985. *The coastal lagoons of East Anglia, U.K.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.
- BARNES, R.S.K. 1984. *The coastal lagoons of East Anglia, U.K. Field survey record sheets.* (CSD Report, No. 600.) Peterborough: Nature Conservancy Council.

Eosehithe Broad (aerial photograph
RC8 CQ 107 Univ. Camb.)





SITE NAME: Aldeburgh and Shingle Street Lagoons

LOCATION: River Alde/River Ore, Suffolk

GRID REFERENCE: TM 458 527 - TM 361 418

TYPE/CLASSIFICATION: Percolation

DESIGNATION: SSSI, NNR, cSAC

AREA (ha): 5

MAX DEPTH (m): 1.5

SALINITY (‰): 16-34

ADJACENT HABITATS: Shingle

SURVEY DATE: 1989

SURVEYOR: M Sheader & R Bamber

ADDITIONAL SURVEYS: R Bamber, 1989, RSK Barnes 1985, Downie & Cottle 1996

MANAGEMENT:

Lagoon Description

The 7 lagoons at Shingle Street (see Map 13, which is taken from Bamber (1989)), south of the river Ore, are essentially gravel-bedded, occasionally with muddy sediments of the sampled lagoons and their locations. Of seven lagoons surveyed in October 1988, two showed clear signs of having recently dried out. The ephemeral nature of this system was demonstrated by the fact that, of eight lagoons identified for the area by Cobb (1958), one had completely dried up and two more were no longer in existence. This numbering system is indicated in brackets where the lagoon is still in existence and is illustrated in Map 13.

A visual inspection of the 7 Shingle Street lagoons was carried out in July 1996, by A. Downie (EN Maritime Team) and R. Cottle (EN Suffolk Local Team). Some slides (12) of the visit are lodged in the Maritime Team collection. P1 and P4 were the only two lagoons we were definitely able to locate. Major shingle movement has occurred all along this site especially at the mouth of the river Ore. P2 has gone but Cobb's lagoon 0 was still present and is regarded as a location for *Nematostella* (R. Barnes pers comm.).

The lagoons are maintained by percolation through the shingle, with supplementary "overtopping" on extreme high tides. The salinities ranged from 16 to 34‰. Characteristic lagoonal plants present were *Chaetomorpha* (lagoons 3 and 4) and *Ruppia spiralis* (lagoons 1, 6 and 7). Also shown is the fauna from a lagoon to the south end of Sudbourne Beach, next to the river Alde (lagoon 8). This lagoon, containing both *Chaetomorpha* and *Ruppia*, represents the brackish pond system on the marshes of Orford Ness and is a comparable habitat to the Shingle Street system. (The lagoons of Havergate Island, between Sudbourne Beach and Shingle Street, have been reported on by Mason, 1986; his survey found none of the classic lagoonal species in what proved to be a stressed habitat; these lagoons are not considered further.)

The Shingle Street fauna includes classic lagoonal species, such as the cockle *Cerastoderma glaucum*^{a,f}, the ostracod *Cyprideis torosa*, the harpacticoid *Paramphiascopsis giesbrechti*, the isopod *Idotea chelipes*^f and the gastropods *Littorina saxatilis tenebrosa*^f and *Hydrobia ventrosa*^{a,f}. The presence of the oligochaete *Limnodrilus hoffmeisteri* in lagoons 3, 4 and 8 is a little surprising insofar as this is normally a low salinity species.

Of particular interest is the nationally rare *Nematostella vectensis*^{*,e,f}, an Edwardsiid anemone found only in lagoons in England and protected under the Wildlife and Countryside Act: it

was present in lagoons 3, 6 and 8. It was recorded from lagoon 4 by Williams (1975), where it was still present in 1984, but was not recorded there by the 1988 survey. It has recently been found lagoon 3; its discovery in lagoons 6 and 8 represent new sites for *Nematostella*.

The records of *Akera bullata* in lagoon 8 represent the first live records for this species in East Anglia.

P1, (= Cobb's lagoon 4) TM 372 434, 26-33°/∞. Elongate lagoon immediately behind the shingle bank, with observed seawater percolation; rapidly sloping gravel to a generally hard shingle bottom, no fine sediment near the edges; submerged macrophytes *Enteromorpha* sp. and some *Ruppia cirrhosa*^f; surrounded by saltmarsh plants. Formed c. 1940 as a result of natural shingle movement. Damage has occurred to this lagoon from recent shingle movement, as witnessed in a visual inspection by A. Downie & R. Cottle, EN Suffolk LT, in 1996.

P2, (= Cobb's Lagoon 7) TM 374 437, 34°/∞. Large lagoon behind the shingle bank, generally shallow, with gravel and soft mud bed, *Enteromorpha* sp. and *Ulva* sp.; surrounded flora as lagoon P1. Since the 1989 survey this lagoon has been eliminated by storm induced incursion of shingle, in 1990 (R. Bamber pers comm.). This lagoon has disappeared, due to recent shingle movement as witnessed in a visual inspection by A. Downie & R. Cottle in 1996.

P3, (= Cobb's lagoon 6) TM 373 437, 33°/∞. Elongate, narrow lagoon inland of lagoon P2, shallow (maximum depth 0.25m) with much plant life (including *Enteromorpha* sp., *Ulva* sp. and *Chaetomorpha* sp.) and muddy substrate; adjacent open gravel to the south otherwise surrounding flora as lagoon P1. Formed c. 1940 naturally, but subsequently used as a borrow pit and deepened. Now largely infilled.

P4, (= Cobb's lagoon 1) TM 363 419, 34°/∞. Largest lagoon of this group just to the south of Shingle Street, with a notable central island. Gravelly bed with softer muds, much plant life (*Chaetomorpha* sp. and *Ulva* sp.) and localised sulphuretum. Lagoon still present but recent shingle movement has had some impact, as witnessed in a visual inspection by A. Downie & R. Cottle in 1996.

P5, TM 362 418.5, 26°/∞. Very small circular pond, surrounded by dense grasses, not notably faunistic.

P6, TM 361.5 418.5, 26°/∞. Larger companion to pond P5, beneath the sea wall, muddy gravel bed showing signs of recent drying-out (cracking, etc); some *Ruppia cirrhosa*^f.

P7, TM 363 421, 16°/∞. Shallow lagoon in corner of sea walls, continuous with (though unconnected to) freshwater ditch inland of the sea wall; muddy bed again showing evidence of recent drying-out; much plant life, largely *Ruppia cirrhosa*^f, and dense swarms of planktonic copepods. Unable to locate this lagoon in 1996 during a visual inspection of the site by A. Downie & R. Cottle.

P8, (Otherwise known as Aldeburgh P8) TM 458 527, 37°/∞. Most northerly of the eight lagoons situated next to the river Alde. Large lagoon with smaller offshoots, south Sudbourne Beach, in corner of the sea walls and shingle bank, connected by a stream-like spur to shingle-bank percolation. Fine mud and gravelly bed, with *Ulva*, *Enteromorpha*, *Chaetomorpha* and *Ruppia spiralis*; local sulphureta.

Also in this category the drainage ditch at Aldeburgh, 52.07.76'N 1.36.26'E, OS Grid Ref TM 461 542, was examined in passing, and found to support a rich fauna, including *Carcinus*, *Palaemonetes* and *Urticina*.

The following species list gives those fauna found in the different lagoons by Bamber (1989).

SPECIES LIST AND ABUNDANCE IN SHINGLE STREET LAGOON SYSTEM

LAGOON SALINITY (‰)	1 32	2 34	3 33	4 34	5 26	6 26	7 16	8 37
SPECIES PRESENT								
<i>Elphidium williamsoni</i>				r				o
<i>Enoplus brevis</i>								o
nematode		a	f	f				f
<i>Sagartia troglodytes</i>	c	c	c	o				a
<i>Nematostella vectensis</i> ^{mf}			o			a		c
<i>Lineus ruber</i>	o		o	a		o		a
<i>Amphiporus lactifloreus</i>	r			r				r
<i>Golfingia minuta</i>	a							
<i>Tubificoides benedii</i>		a	a	c		c		c
<i>T. cf. diazi</i>				r				o
<i>Tubifex costatus</i>				c				
<i>Limnodrilus hoffmeisteri</i>	o	a	o	o				r
<i>Capitella capitata</i>			a	c				c
<i>Arenicola marina</i>	c		p	p				p
<i>Hediste diversicolor</i>			c					
<i>Malacocerus fuliginosus</i>		a						o
<i>Scolelepis foliosa</i>		o						
<i>Manayunkia aestuarina</i>			r	r				
<i>Fabrica sabella</i>								r
<i>Abra tenuis</i>		o	c	a				
<i>Cerastoderma glaucum</i> ^f				f				c
<i>C. edule</i> (dead shells only)	p	p						
<i>Acteon tornatilis</i> (dead shells only)				f				
<i>Hydrobia ulvae</i>		a						
<i>H. neglecta</i> ^f	a		c					
<i>H. ventrosa</i> ^f	a		c			a	a	a
<i>Leucophytia bidentata</i>				r				
<i>Littorina saxatilis tenebrosa</i> ^f			c	c				a
<i>Akera bullata</i>								a
<i>Retusa obtusa</i>								a
chironomid			c	o	c	c		
<i>Ephydra</i> sp.							r	f
coleoptera							r	
dipteran larva							r	
<i>Sigara stagnalis</i>			r				a	
<i>Cyprideis torosa</i>			o	r				
<i>Paramphiascopsis giesbrechti</i>				c				o
<i>Eurytemora velox</i>							a	
<i>Idotea chelipes</i> ^f							a	
<i>Microdeutopus gryllotalpa</i>		c	o					a
<i>Gammarus finmarchicus</i>		c						
<i>G. locusta</i>			o			a		
<i>Orchestia gammarellus</i>				c				
<i>Corophium volutator</i>			c			o		
<i>Melita palmata</i>			a					c
<i>Palaemonetes varians</i>	c							o
<i>Amphipholis squamata</i>								c
<i>Anguilla anguilla</i>								r
<i>Gasterosteus aculeatus</i>				r				r

Abundance scale used in table:

a = abundant	c = common
f = frequent	r = rare
o = occasional	p = present

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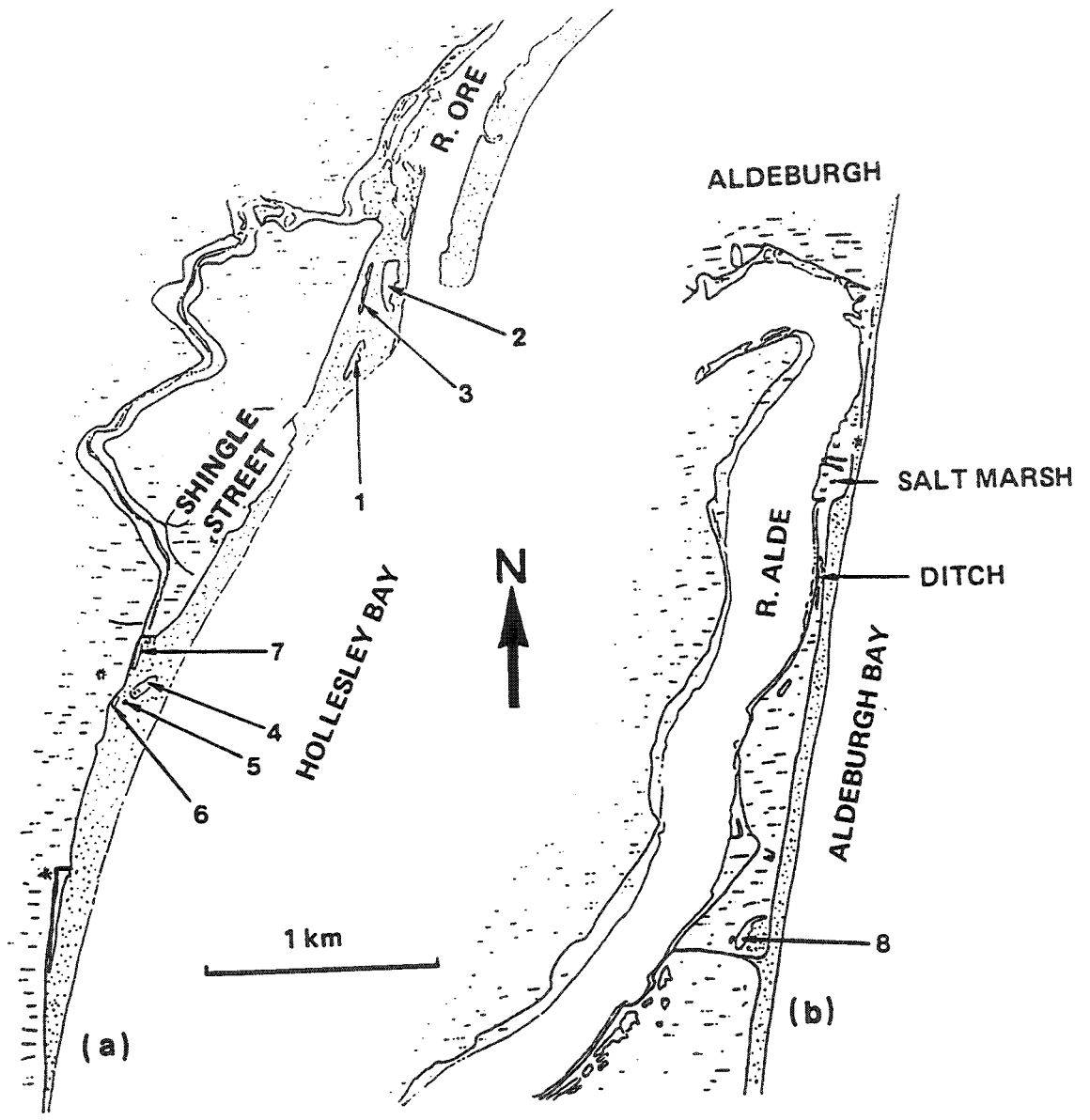


FIG. 2 SHINGLE STREET (a) AND ALDEBURGH (b), SHOWING LAGOONS 1 TO 8 SAMPLED IN OCTOBER 1988 BY PORCUPINE; THE DISTANCE BETWEEN THE NORTH OF 'a' AND THE SOUTH OF 'b' IS 7 KILOMETRES

SITE NAME:	King's Marshes, Orford Ness
LOCATION:	Orfordness, Suffolk
GRID REFERENCE:	TM 445 450
TYPE/CLASSIFICATION:	Percolation
DESIGNATION:	SSSI, NNR, cSAC, NT reserve
AREA (ha):	?
MAX DEPTH (m):	?
SALINITY (‰):	11-20
ADJACENT HABITATS:	Shingle
SURVEY DATE:	1994
SURVEYOR:	R S K Barnes
MANAGEMENT:	Managed as a NT reserve

Lagoon Description

The brackish pools on the King's Marshes, Orfordness (see Map 14, which is taken from Downie & Barnes (1996)) consist of 9 separate pools (pools 5 & 7 on map were identified as being one at the time of the survey) (Downie & Barnes 1996).

Salinity of the surveyed pools varied between 11 and 20 ‰ (ie 31-57 % seawater). This, however, will vary seasonally with the evaporation/precipitation ratio and also with the extent of sea water incursion, and hence these September values should only be taken to be indicative of prevailing salinities. The freshwater component of the water is clearly derived from rainfall; it is most likely that the sea water component enters continually by seepage through the shingle substratum and from Stony Ditch. All the pools are connected to each other to a greater or lesser extent via the numerous drainage ditches that criss-cross the Marshes, and hence salts can flow or diffuse through the whole system. The order of increasing salt concentration in the pools at the time of the visits runs: 9 & 10 (11 ‰); 3 (14-15 ‰); 5/7 (17-18 ‰); 1,4,6 & 8 (19-20 ‰).

The fauna of the individual pools are very similar, and it is likely that all the species recorded occur in all the pools. Where a species appears to be particularly abundant in only a few of the pools, however, such is noted. The list is unlikely to be exhaustive, but it certainly includes all the dominant elements in the fauna. All pools supported submerged stands of tasselweed *Ruppia*, with which, as in lagoons in general, many of the animals are associated.

The species present are a typical brackish-water/lagoonal assemblage, although the presence of all of them together in the King's Marshes pools makes the site one of the richer ones in the country. However, the King's Marshes fauna is almost identical to that of the lagoons of the onland shingle at the end of Orfordness (from Shingle Street to Bawdsey), just to the south, and to that of the lagoons landwards of the Walberswick to Dunwich shingle ridge to the north. The presence of *Sphaeroma monodi*, absent from the other two sites, is presumably indicative of the estuarine conditions along the western margin of Orfordness.

The presence of *Nematostella vectensis*^{a,f} is noteworthy because this small, rare anemone is specifically protected under Schedule 8 of the Wildlife & Countryside Act 1981. The occurrence of *Hydrobia neglecta*^{a,f}, *Littorina saxatilis lagunae* and *Cerastoderma glaucum*^{a,f} is noteworthy of comment in that they are far from common species nationally, although the first and last also occur at the other two Suffolk sites mentioned above. The population density of *C. glaucum*^{a,f} on the King's Marshes is greater than at many other British localities in which it occurs. The lagoon winkle *Littorina saxatilis lagunae*, is not otherwise known from Suffolk (although it is abundant at one Norfolk site); it is particularly associated with *Ruppia*.

In summary, the fauna is typical of Suffolk percolation-fed lagoons, with a few interesting additions, although the lagoonal fauna of the stretch of Suffolk coast between Walberswick and Bawdsey is far from typical in the national context, being one of the three or four richest such stretches in Britain. From the faunistic point of view, it is suggested that the lagoons from Walberswick to Bawdsey should be treated as one single lagoon complex.

Management

By-and-large, such lagoons maintain themselves with little active management. The only two potential threats (besides of course reclamation) are changes to the hydrological regime and, being shallow, encroachment by reeds (*Phragmites*) which can withstand salinities of the order of those quoted above. Any activities which would lead to reduced sea-water percolation through the shingle and to the movement of the salts through the system would lead to impoverishment of the fauna, as would natural succession to reedswamp (reeds are already established at places in Pool 1). Grazing of the surrounding land would not affect the fauna, unless it would lead to nutrient enrichment of the pools (with consequent growth of blanket green algae and deoxygenation), which is unlikely. Periodic inundation by the sea would not pose any threat to the fauna, in that they can all withstand full strength sea water; it may even be beneficial in ensuring an even distribution of the various species between the different pools, thereby reducing the risk of local extinction. None of the pools are likely to be infilled.

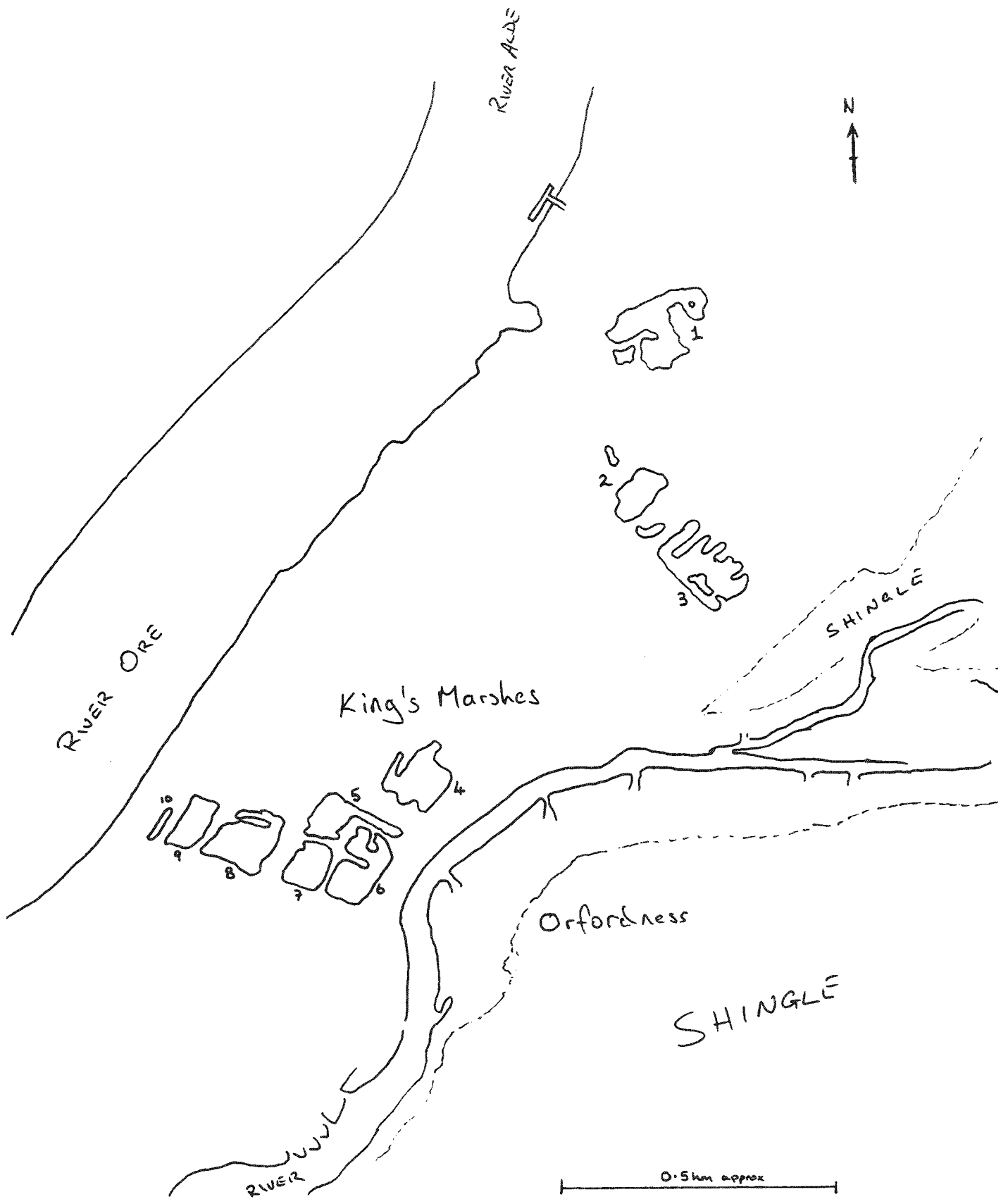
Species present

<i>Nematostella vectensis</i> ^{**e,f}	(particularly pool 9)
<i>Hediste diversicolor</i>	(particularly pool 8)
<i>Hydrobia ventrosa</i> ^{a,f}	(much the commoner of the two <i>Hydrobia</i> species)
<i>Hydrobia neglecta</i> ^{a,f}	(particularly pool 8)
<i>Littorina saxatilis langunae</i>	(particularly - only? - pool 1)
<i>Cerastoderma glaucum</i> ^{a,f}	
<i>Idotea chelipes</i> ^f	
<i>Sphaeroma monodi</i>	(particularly pools 1,2 & 4)
<i>Jaera albifrons</i>	
<i>Gammarus duebeni</i>	
<i>Gammarus oceanicus</i>	
<i>Corophium volutator</i>	
<i>Corophium insidiosum</i> ^f	
<i>Palaemonetes varians</i>	
<i>Electra crustulenta</i>	(particularly pools 1 & 4)
<i>Sigara selecta</i>	
chironomid larvae	
<i>Gasterosteus aculeatus</i>	

References

DOWNIE, A.J. & BARNES, R.S.K. 1996. Survey of the brackish pools on the King's Marshes, Orfordness, Suffolk - 1994. *English Nature Research Report No. 209*.

Map 14. The brackish pools on the King's Marshes, Suffolk.



SITE NAME:	Rye Harbour Nature Reserve Lagoon
LOCATION:	Rye Harbour, East Sussex
GRID REFERENCE:	TQ 940 178
TYPE/CLASSIFICATION:	Percolation
DESIGNATION:	Rye Harbour SSSI, Rye Harbour LNR
AREA (ha):	5.0
MAX DEPTH (m):	0.5
SALINITY (‰):	5
ADJACENT HABITATS:	Shingle and associated vegetation
SURVEY DATE:	August 1987
SURVEYOR:	M & A Sheader
MANAGEMENT:	

Lagoon Description

This is a flooded gravel pit situated in an extensive area of shingle at Rye Harbour, and is one of only two brackish lagoons in a group of flooded gravel pits (see Map 15, which is taken from Sheader & Sheader (1987b)). This is an area of rapid shingle accretion, with over 3km of shingle beach being formed over the last 800 years. The lagoon is a bird reserve, run and managed by the Rye Harbour Nature Reserve (LNR), with observation hides on the northeast and southwest margins. Access to the lagoon and its surrounding shore is restricted by an anti-predator electric fence and a shingle bank. Islands within the lagoon were created about six years ago by the landscaping department of the Southern Water Authority, and are used extensively for nesting by a variety of sea birds. When visited, there were large numbers of wildfowl and waders in and around the lagoon.

The lagoon is sited in an area of shingle and hidden from view by a shingle bank. The shingle supports a rich flora, including the sea pea *Lathyrus maritimus* and sea kale *Crambe maritima*. The surrounding bank slopes rapidly to a narrow shore with no strandline apparent when visited. *Scirpus maritimus* and *Phragmites australis* occur as emergents, patchily distributed on all margins. *Enteromorpha* sp. and *Ulva lactuca* are present - both attached and unattached, but the dominant submerged weed within the lagoon is *Potamogeton pectinatus*.

There is no obvious freshwater input to the lagoon, with seawater presumably entering by percolation. The sediment was soft mud and shingle.

Species present

Lathyrus maritimus

Crambe maritima (on surrounding shingle)

Phragmites australis

Scirpus maritimus

Enteromorpha sp.

Ulva lactuca

Potamogeton pectinatus

Hydrobia ventrosa^{a,f}

Cerastoderma glaucum^{a,f}

Hediste diversicolor

Gammarus duebeni

Gammarus zaddachi

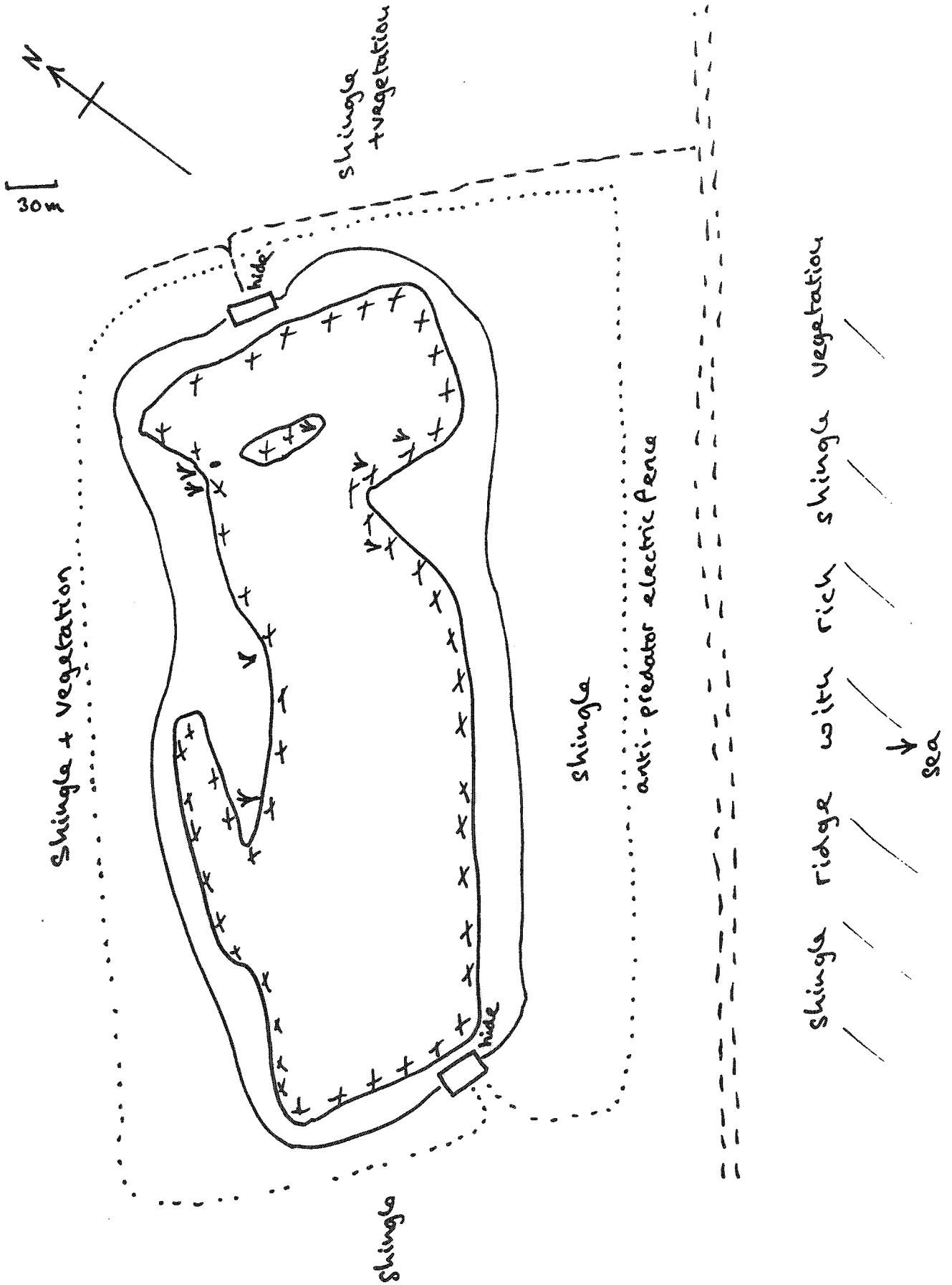
talitrid

Palaemonetes varians
Chironomus sp.
coleoptera (3 spp.)
Sigara stagnalis
Gasterosteus aculeatus

The scope of the survey was restricted by birdwatching activities.

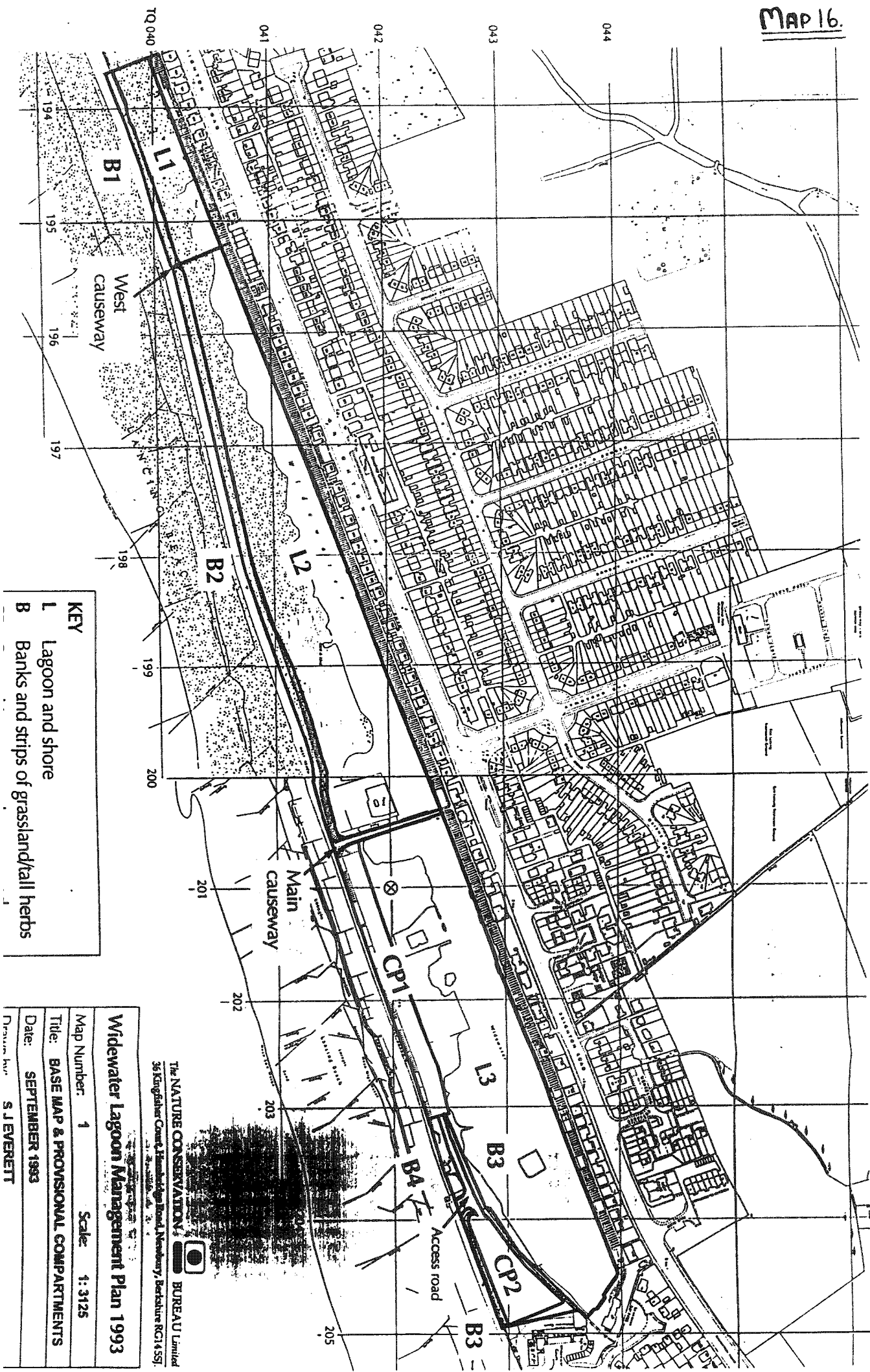
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- x - Scirpus
- y - Phragmites.

N.B. More islands (total 4) are present but are not marked.



KEY

- L Lagoon and shore
- B Banks and strips of grassland/tall herbs

Widewater Lagoon Management Plan 1993

Map Number: 1 Scale: 1:3125

Title: **BASE MAP & PROVISIONAL COMPARTMENTS**

Date: **SEPTEMBER 1993**

Drawn by: **S J EVERETT**

THE NATURE CONSERVATION BUREAU Limited
 36 Kingsolver Court, Hantsbridge Road, Newbury, Berkshire RG14 5SF

SITE NAME:	The Fleet
LOCATION:	Chesil Beach, Dorset
GRID REFERENCE:	SY 570 840 - 660 750
TYPE/CLASSIFICATION:	Sea Inlet
DESIGNATION:	Chesil Beach and The Fleet SSSI, cSAC.
AREA (ha):	480
MAX DEPTH (m):	5.2
SALINITY (‰):	3-34
ADJACENT HABITATS:	Chesil Beach to west. Calcareous grassland to east.
SURVEY DATE:	Still being studied
SURVEYOR:	Numerous
MANAGEMENT:	Privately owned by Fox Strangeways Estates

Lagoon Description

The Fleet, separated from the sea by the great shingle bank of Chesil Beach is probably the most important saline lagoon in England (see Map 17, which is taken from Dyrinda (1984)). With an area of 480 ha it is over 10 times the size of the next largest lagoon at Cliffe Fort on the Solent and represents almost 40% of the total English saline lagoon resource of 1215 ha.

Due to its size, the range of different habitats present and the species diversity this report can only attempt to outline the basic characteristics of the Fleet, eg the Fleet contains at least 150 species of algae. For further information and detail a number of references are listed.

The Fleet is a lagoon extending 13 km north west along the Dorset coast occupying the area between Chesil Beach and the mainland. The width varies between 66 m in the Narrows to over 910 m across Butterstreet Cove. Tidal flow is restricted by the narrow outlet at Smallmouth and the maximum range varies from about 2 m there to about 0.15 m near the Swannery. In general, the lower Fleet is of marine or near marine salinity up to Butterstreet Cove which marks the limit of effective tidal flow, the middle section is high salinity brackish whereas the uppermost is low salinity brackish.

Physico-chemical conditions are discussed at length in Whittaker (1980). The depth of water at low tide is generally about 1 m or less except in a few channels and depressions and at the narrow marine inlet at Smallmouth (Ferrybridge) where the maximum depth of 5.2m CD occurs. A study of the nutrient status, hydrographical features and phytoplankton composition was recently completed by Haf John (1995). The information presented could provide a base-line upon which future monitoring changes in the Fleet nutrient status and also seasonal variations in nutrient levels could be based.

The bed of the lower Fleet is of sand or muddy sand, with intertidal flats, but in the vicinity of the Narrows it is rocky or pebbly, with rock ledges which create rapids at low tide. From the Narrows to Butterstreet Cove, extensive mud flats are exposed at low tide, intersected by deep channels, while the upper part of the Fleet is largely floored with soft mud most of which is never exposed.

Freshwater inflow is relatively small and silting is largely derived from rotting vegetation. The vegetation of the lower section mainly composed of red and brown algae to just above the Narrows, but the remainder of the Fleet is dominated by meadows of *Zostera* species, tasselweed *Ruppia spiralis*, and luxuriant annual growths of green algae.

As this brief account illustrates, there exists within The Fleet a wide range of habitat types which vary in salinity, substrate type, dissolved oxygen, current and depth. It is, therefore, perhaps not surprising that the species diversity recorded, both in terms of numbers and habitat specialisation, is so much higher than has been found in any other British lagoon. It supports a characteristic suite of lagoonal plants and animals along with many lagoonal specialists. To date over 210 species of fauna and flora have been found, including the saline lagoon sandworm *Armandia cirrhosa*^{**e,f} - A NEW SITE RECORD FOR THIS SPECIES (Downie 1996).

Species present

Rhodophyceae

Ahnfeltia plicata
Antithamnion plumula
Audouinella purpurea
Audouinella secundata
Audouinella thuretii
Calliblepharis cilata
Calliblepharis jubata
Catanella caespitosa
Ceramium ciliatum
Ceramium diaphanum
Ceramium echionotum
Ceramium pedicellatum
Ceramium rubrum
Chondria dasyphylla
Chondria tenuissima
Chondrus crispus
Chylocaldia verticillata
Corallina officinalis
Cordylecladia erecta
Cystoclonium purpureum
Dermatolithon cystoseirae
Dumontia incrassata
Erythrotrichia carnea
Fosliella farinosa
Fosliella lejolisii
Furcellaria lumbricalis
Gelidium pusillum
Gigartina acicularis
Gloiosiphonia capillaris
Gracilaria bursa-pastoris
Gracilaria foliifera
Gracilaria verrucosa
Grateloupia filicina var. *filicina*
Grateloupia filicina var. *luxurians*^d
Griffithsia corallinoides
Griffithsia flosculosa
Gymnogongrus griffithsiae
Halopityis incurvus
Hildenbrandia rubra
Holmsella pachyderma

Phaeophyceae

Acrothrix gracilis
Asophyllum nodosum
Asperococcus fistulosus
Asperococcus turneri
Chorda filum
Cladosiphon contortus
Cladosiphon zosterae
Cladosiphon spongiosus^f
Colpomenia peregrina^d
Spongiosus
Cladostephus spongiosus^f
Verticillatus
Colpomenia peregrina
Cylindrocarpus microscopicus
Cystoseira foeniculacea
Cystoseira nodicaulis
Dictyota dichotoma
Ectocarpus fasciculatus
Ectocarpus siliculosus
Elachista fucicola
Fucus serratus
Fucus spiralis
Fucus vesiculosus
Giffordia granulosa
Giraudia sphacelarioides
Hecatonema maculans
Laminaria saccharina
Litosiphon pusillus
Myriactula rivulariae
Myrionema strangulans
Padina pavonia
Phaeostroma pustulosum
Pilayella littoralis
Punctaria latifolia
Scytosiphon lomentaria
Spongonema tomentosum
Striaria attenuata
Sargassum muticum^d

Jania rubens
Laurencia obtusa
Laurencia pinnatifida
Lithophyllum incrustans
Membranoptera alata
Palmaria palmata
Peysonnella dubyi
Phyllophora crispa
Phyllophora pseudoceranoides
Phyllophora sicula
Phymatolithon lenormandii
Plocamium cartilagineum
Polyides rotundus
Polysiphonia elongata
Polysiphonia lanosa
Polysiphonia nigrescens
Polysiphonia urceolata
Porphyra linearis
Porphyra umbilicalis
Rhodophyllis divaricata
Rhodophysema elegans
Schottera niaensis
Scmitziella endophloea
Solieria chordalis^d
Sphodylothamnion multifidum
Spyridia filamentosa

Cyanophyceae

Agmenellum sp.
Anabaena sp.
Calothrix crustacea
Entophysalis conferta
Microcoleus lyngyaceus
Microcystis sp.
Nodularia spumigena
Schizothrix arenaria

Gastropoda:

Loricata

Lepidochitona cinereus

Opisthobranchia

Haminoea navicula
Akera bullata
Runcina coronata
Odostomia plicata
O. unidentata
Turbonilla elegantissima
Berthella plumula
Alderia modesta
Elysia viridis

Chlorophyceae

Ulva lactuca
Chaetomorpha linum^f
Cladophora battersia
C. retroflexa
Enteromorpha spp.

Xanthophyceae

Vaucheria spp.

Macrophytes

Zostera agustifolia
Zostera nolti
Ruppia cirrhosa^f
Ruppia maritima^f
Ruppia spiralis

Stoneworts

Lamprothamnium papulosum^f

Prosobranchia

Emarginula conica
Patella vulgata
Acmaea virginea
Gibbula cineraria
G. umbilicalis
Gibbula magus
Littorina littorea
L. saxatilis
L. saxatilis tenebrosa^f

Limapontia senestra
Acanthodoris pilosa
Palio dubia
Aeolidia papillosa
Aeolidiella alderi
Eubbranchus farrani
Eubbranchus sp.
Eubbranchus cingulatus
*Tenellia adspersa**e,f*
Trinchesia foliata

Pulmonata

Leucophytia bidentata
Phytia myosotis

Lamellibranchia

Nucula turgida
Mytilus edulis
Musculus marmoratus
Loripes lucinalis
Cardium exiguum
Cardium edule
Cerastoderma glaucum^{a,f}
Venus verrucosa
Venus casina
Mercenaria mercenaria^d
Venerupis aurea
Venerupis decussata
Irus irus
Tellina squalida
Macoma balthica
Scrobicularia plana
Abra tenuis
Solen marginatus
Sphenia binghami
Corbula gibba
Barnea parva
Ostrea edulis

Oligochaeta

Tubificoides benedii
Tubificoides pseudogaster

Siphunculoidea

Golfingia elongata

L. littoralis
Hydrobia ventrosa^{a,f}
Hydrobia ulvae
Truncatella subcylindrica
Cingula semicostata
Cingula cingillus
Alvania crassa
Rissoa parva
Rissoa guerinii
Rissoa membranacea
*Paludinella littorina**e*
Rissoella diaphana
Bittium reticulatum
Cerithiopsis tubercularis
Calyptraea chinensis
Crepidula fornicata^d
Ocenebra erinacea
Lamellaria perspicua
Nassarius incrassatus
Nassarius reticulatus
Mangelia brachystoma

Coelenterata

Anemonia viridis
Anemonia sulcata
Obelia geniculata
Actinia equina
*Nematostella vectensis**e,f*

Polychaeta

Sabellaria sp.
Hediste diversicolor
Nephtys hombergi
Glycera lapidum
Lumbriconeris lattarelli
Scoloplos armiger
Scolecopsis fuliginosa
Audouinia tentaculata
Cirratulus cirratus
Flabelligera affinis
Notomastus latericeus
Capitella capitata
Arenicola marina
Pomatoceros triqueter
Pomatoceros lamarcki
Spirorbis cuneatus
Spirorbis tridentatus
Spirorbis coralline
*Armandia cirrhosa**e,f*
Ampharete acutifrons
Hydroides sp.
Hydroides norvegica

Insecta

Clunio marinus
Chersodromia arenaria
Ceratinosoma ostiorum

Tunicata

Botryllus scholsseri
Diplosoma listerianum
Clavelina lepadiformis

Porifera

Halichondria bowerbanki
Hymeniacidon perleve
Suberites massa
Dysidea fragilis
Sidnyum turbinatum
Polymastia mamillaris

Chelicerata

Achelia echinata
Nymphon gracile

Echinodermata

Asterina gibbosa

Cnidaria

Monothecha obliqua
Sertularia argentea
Urticina felina
Aureliania heterocera

Pisces

Gasterosteus aculeatus

Plankton:**Centric Diatoms**

Bellerochea malleus
Biddulphia rhombus
Cerataulina sp.
Coscinodiscus sp.
Guinardia flaccida
Leptocylindricus danicus
Rhizosolenia spp.
R. alata
R. delicatula
R. stliformis
R. stolterfothii
Skeletonema costatum

Crustacea

Gammarus insensibilis^{**a,e,f}
Gammarus duebeni
Gammarus zaddachi
Melita palmata
Microdentopus gryllotalpa
Idotea chelipes^f
Cyathura carinata
Ligia oceanica
Homarus gammarus
Sphaeroma rugicauda
Palaemon adspersus
Palaemon elegans
Carcinus maenas
Inachus dorsttensis
Cancer pagurus
Corophium volutator
Corophium sextonae^d
Corophium acutum
Verruca stroemia
Caprella acanthifera
Phtisica marina
Lysianassa ceratina
Cymodoce truncata
Balanus crenatus

Bryozoa

Alcyonidium mytili
Celleporella hyaline
Electra pilosa
Bowerbankia gracilis
Walkeria uva
Cryptosula pallasiana

Pennate Diatoms

Achnathes longipes
Amphora coffeaformis
Bacillaria sp.
Fragilaria sp.
Gyrosigma sp.
Navicula spp.
Pleurosigma sp.
Thalassionema spp.
T. nitzschoides

Stephanopyxis
Thalassiosira sp.

Dinoflagellates

Prorocentrum sp.
Oxyrrhis sp.
Glenodinium foliaceum
Thecate dinoflagellate sp.
Flagellate spp.

Zooplankton

Cladocercan sp.
Copepod sp.

Ciliates

Strombidium sp.
Tinntinnopsis sp.

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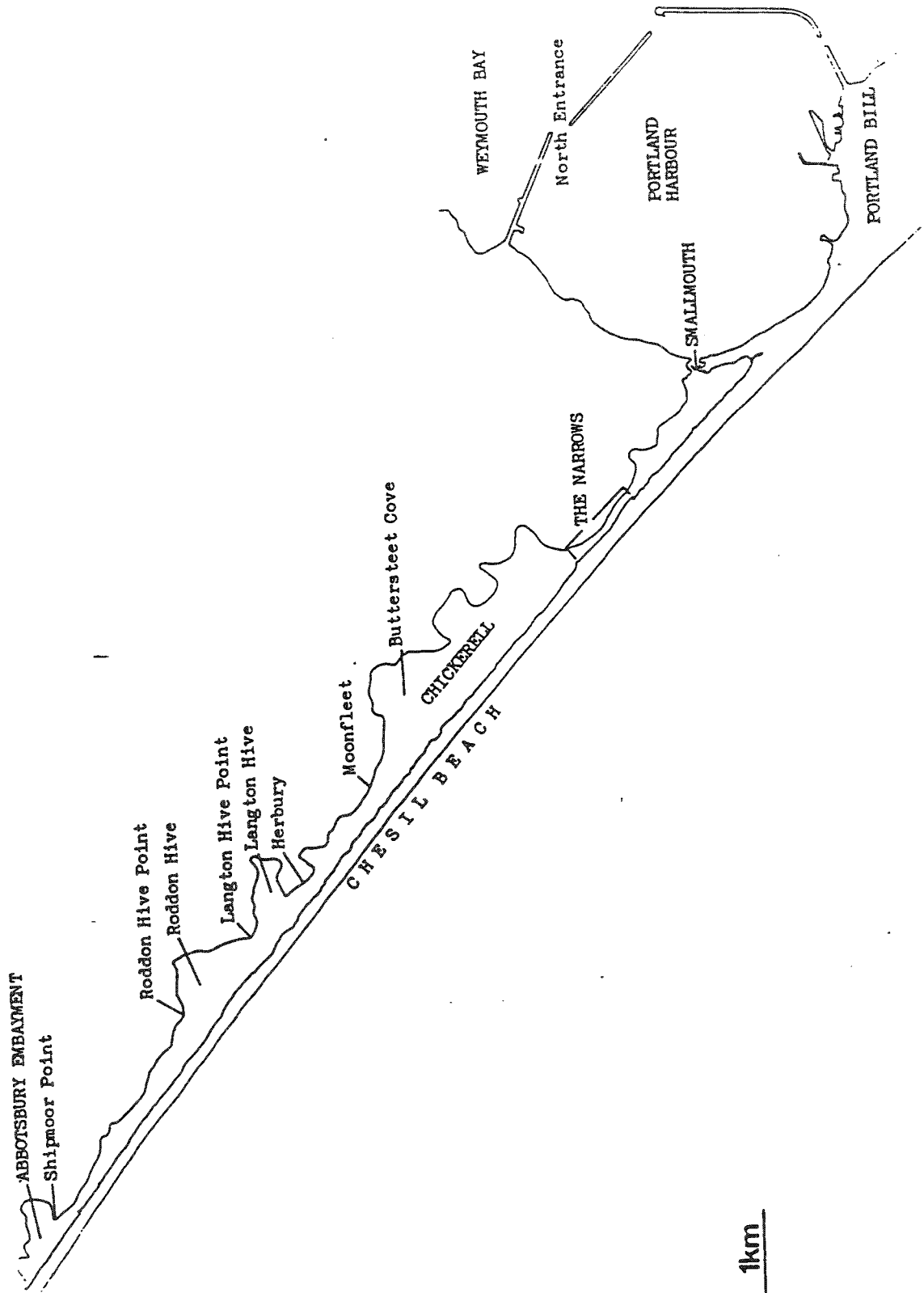


Fig. 1
The Fleet Lagoon and Portland Harbour.

