EC Regulation 854/2004

CLASSIFICATION OF BIVALVE MOLLUSC PRODUCTION AREAS IN ENGLAND AND WALES

SANITARY SURVEY REPORT

Portland Harbour - Dorset

2009

Cover photo: suspension lines and storage bags on Bincleaves Breakwater.

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STATEMENT OF USE: This report presents the results of a sanitary survey of bivalve mollusc production areas in Portland Harbour. Its primary purpose is to demonstrate compliance with the requirements for classification of bivalve production areas, laid down in EC Regulation 854/2004 of the European Parliament and of the Council. The Centre for Environment, Fisheries and Aquaculture Science (Cefas) undertook this work on behalf of the Food Standards Agency (FSA).

DISSEMINATION: Food Standards Agency, Weymouth Port Health Authority, Environment Agency.

CONTENTS

EXECUTIVE SUMMARY

Under EC Regulation 854/2004[1], there is a requirement for competent authorities intending to classify bivalve mollusc production and relaying areas (BMPAs) to undertake a number of tasks collectively known (in England and Wales) as ‘sanitary surveys’. The main purpose of these surveys is to inform the sampling plans for the microbiological monitoring programme and classification of BMPAs. Other wider benefits of these surveys include the potential to improve identification of pollution events and the sources of those events such that in the future remedial action can be taken to the benefit of the fisheries.

This report documents the qualitative assessment made of the levels of microbiological contamination in bivalves from Portland Harbour, Dorset and presents the recommended sampling plan as a result of a sanitary survey undertaken by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) on behalf of the Food Standards Agency (FSA).

The assessment is supported by published relevant information for the Portland Harbour area and new information obtained from a shoreline survey performed in the harbour. In addition, statistical analysis of historical data from the Shellfish Hygiene monitoring programme was undertaken. The sampling plan presents information on location of monitoring points, sampling frequency and depth of sampling for a new harvesting area for native and Pacific oysters in the several order in Portland Harbour and for existing harvesting areas for scallops, Pacific oysters and mussels.

There are no significant continuous sewage discharges into Portland Harbour and there is no agricultural land in close proximity to the production area. Therefore, the contribution of pollution sources of human and animal origin that may give rise to contamination of faecal origin impacting BMPAs is considered to be low.

The main sources of contamination likely to impact on shellfisheries in Portland Harbour are storm and emergency sewage overflows located near Wyke Regis, at the north of the harbour, and Castletown, at the south. Contamination from birds and sewage discharges from boats (yachts) may also be significant, although these sources of contamination are likely to be sporadic and unpredictable. Contamination from birds is likely to be most significant in the winter whereas sewage discharges from boats are likely to be most significant in the summer.

The variation in tidal range (2m) relative to the bathymetric profile (16m at Chart Datum) and regular tidal movements moving in a counter clockwise direction in the harbour favour the dispersion and dilution of microorganisms with distance to pollution sources and with time. Consequently, the microbiological water quality in the production area is generally good.

[1] see Section 6, Annex II of the Regulation.

The locations of existing representative monitoring points were reviewed and new monitoring points were defined for the several order site in the Harbour in order to adequately reflect the impact of pollution sources on the BMPAs.

1. INTRODUCTION

Filter-feeding bivalve shellfish can accumulate bacterial and viral pathogens from contaminated waters. The consumption of raw or insufficiently cooked shellfish harvested from such waters can cause illness and lead to outbreaks of infectious disease (e.g. Norovirus associated gastroenteritis, Hepatitis A and Salmonellosis). In order to protect public health, under EC Regulation 854/2004[2], shellfish harvesting and relaying areas are classified on the basis of monitoring of levels of faecal indicator organisms (*Escherichia coli* in the EU) in shellfish. The classification determines the level of treatment required (e.g. purification, relaying or cooking) before human consumption, or may prohibit harvesting.

Annex II (Chapter II paragraph 6) of EC Regulation 854/2004, states that 'if the competent authority decides in principle to classify a production or relay area it must:

i) make an inventory of the sources of pollution of human or animal origin likely to be a source of contamination for the production area;

ii) examine the quantities of organic pollutants which are released during the different periods of the year, according to the seasonal variations of both human and animal populations in the catchment area, rainfall readings, waste-water treatment, etc.;

iii) determine the characteristics of the circulation of pollutants by virtue of current patterns, bathymetry and the tidal cycle in the production area; and

iv) establish a sampling programme of bivalve molluscs in the production area which is based on the examination of established data, and with a number of samples, a geographical distribution of the sampling points and a sampling frequency which must ensure that the results of the analysis are as representative as possible for the area considered'.

In England and Wales, these activities are collectively known as a 'sanitary survey' (Cefas, 2007). The Centre for Environment, Fisheries and Aquaculture Science (Cefas) is performing sanitary surveys for new bivalve mollusc harvesting areas in England and Wales on behalf of the Food Standards Agency (FSA). This report documents information arising from a sanitary survey relevant to new and existing harvesting areas in Portland Harbour, Dorset. The sanitary survey was prompted by applications for classification of the several order bed for the farming of native (*Ostrea edulis*) and Pacific oysters (*Crassostrea gigas*). The harbour contains existing classified zones for the harvesting of king scallops (*Pecten maximus*), Pacific Oysters and mussels (*Mytilus* spp.).

[2] EC Regulation 854/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific rules for the organization of official controls on products of animal origin intended for human consumption.

2. SITE DESCRIPTION

2.1 Background

Portland Harbour is located on the South Dorset coast, between the town of Weymouth to the north and the Isle of Portland to the south (Figure 2.1). The harbour is a semi-artificial deep-water tidal basin, enclosed by man-made breakwaters and protected from the prevailing southwesterly winds by Chesil Beach. Tidal exchange is restricted to three ship channels through the breakwaters and a channel at Ferrybridge that links the harbour to the Fleet, a large saline lagoon. Formerly an important naval base, the harbour now supports a commercial port. The harbour is very popular for a range of water-based recreational activities including angling, sailing, diving, power boating, sail boarding and kite surfing. The 2012 Olympic Games sailing and sail boarding events will be hosted in the harbour at Weymouth and Portland National Sailing Academy.

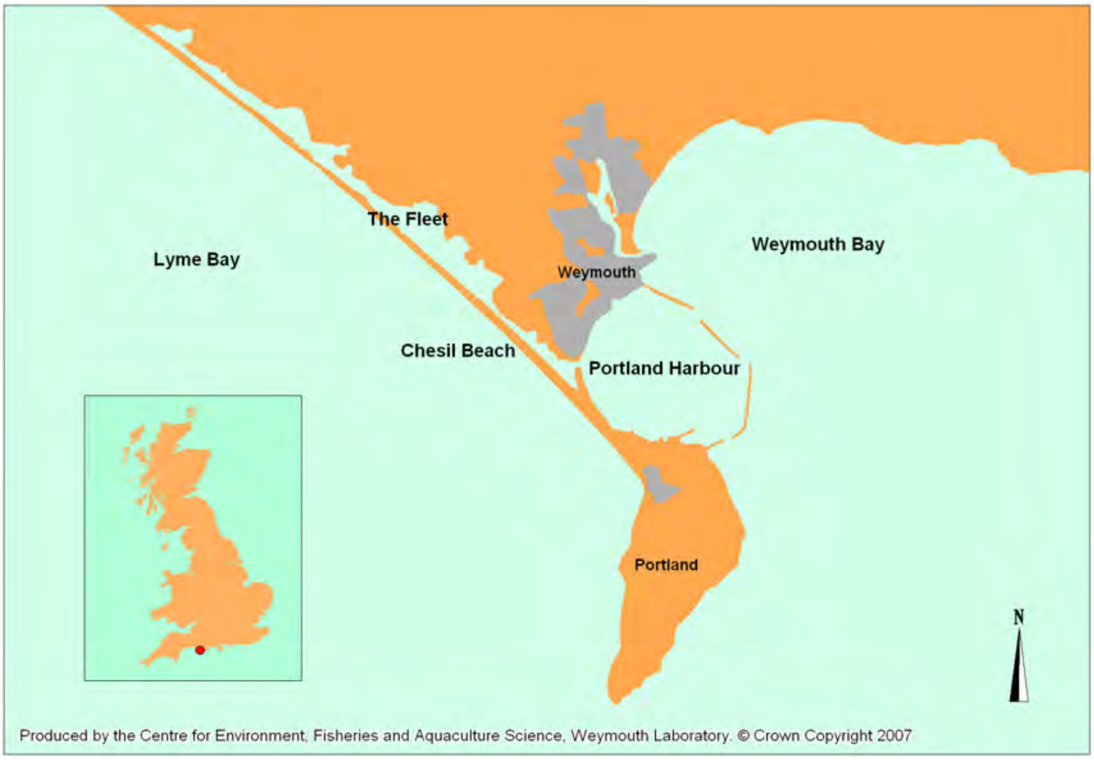


Figure 2.1: Location map of Portland Harbour

The harbour covers an area of approximately 10km^2 and has a maximum depth of 16m below chart datum (LAT). The tidal range in the harbour is relatively small and varies from 0.6 to 2.0m on mean neap and spring tides respectively (UK Hydrographic Office, 2004). The temperature regime and sheltered nature of the harbour accounts for the presence of several marine species beyond the typical northern limits of their range and provides good growing conditions for shellfish (Portland Harbour Authority, 2006; Laing and Spencer, 2006).

2.2 Population and tourism

Weymouth and Portland District had a resident population of 63,648 at the 2001 census (National Statistics, 2007). Weymouth town has an estimated population of 51,760 (2004 figure, Dorset County Council, 2005). Tourism is extremely important to the area and Weymouth has an estimated 983,000 day visitors and 2,225,6000 staying visitor nights per year (South West Tourism, 2006). Seasonal variation in numbers of day and staying visitors to Weymouth is shown in Figure 2.2. The holiday months of July and August are most popular, although there is a small secondary peak in visitor numbers in December.

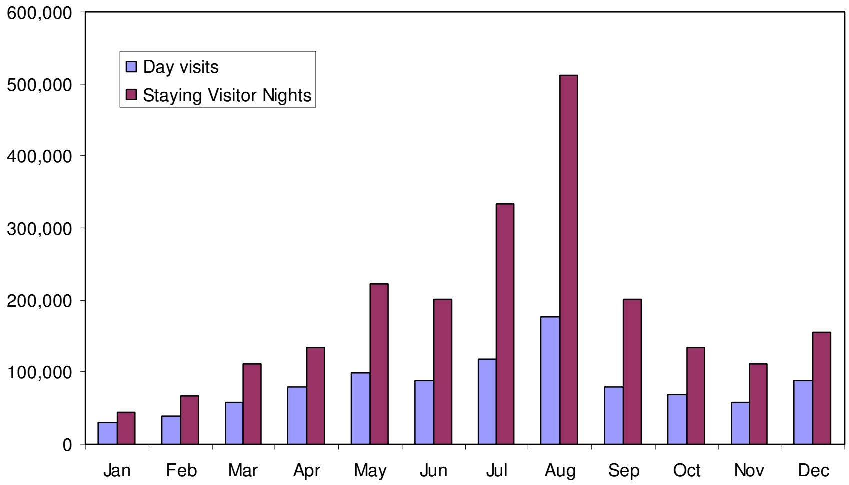


Figure 2.2: Seasonal variation in numbers of day and staying visitors to Weymouth (The Market Research Group, 2007)

The number of visitors to the 2012 Olympic Games sailing events hosted by Weymouth and Portland Sailing Academy is expected to be in excess of 10,000 per day (South West of England Rural Development Agency, 2007). This large influx of visitors over the duration of the Games (27th July to 9th September) will impose additional demands on the local sewerage infrastructure and may cause a temporary increase in the risk of pollution (Environment Agency, 2007a,b).

2.3 Climate

Rainfall at Weymouth averages 727mm per year (Weymouth & Portland Borough Council, 2007b). Seasonal variation in rainfall at Weymouth is shown in Figure 2.3. The highest monthly rainfall totals are in the autumn and winter months, and rainfall-related contamination sources such as storm overflows and runoff from urban areas are likely to be most significant during this period.

Total sunshine duration averages 1882 hours per year at Weymouth (Weymouth & Portland Borough Council, 2007b). Monthly variation in mean duration of sunshine hours at Weymouth is shown in Figure 2.4. The seasonal pattern indicates that the effect of solar radiation on the inactivation of microorganisms in surface waters will be most significant during the summer months (May to August).

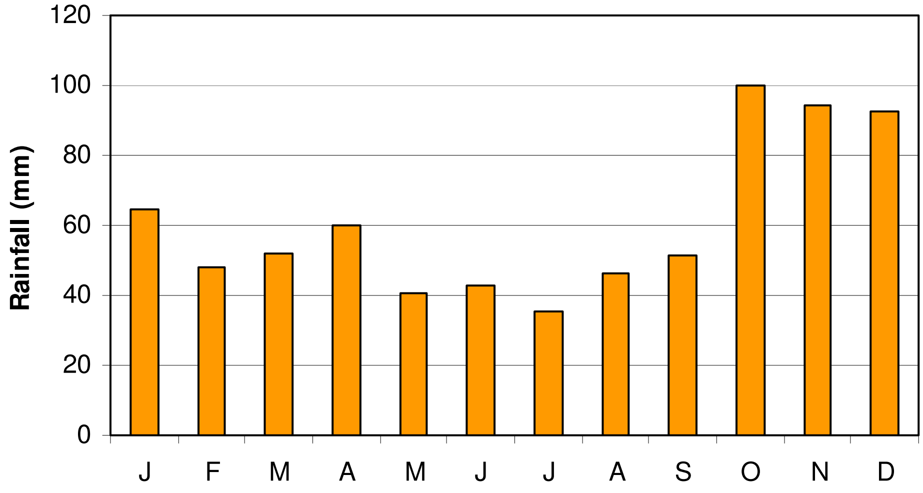


Figure 2.3: Mean monthly rainfall at Weymouth for period 1997-2006 (Data from Weymouth & Portland Borough Council, 2007b)

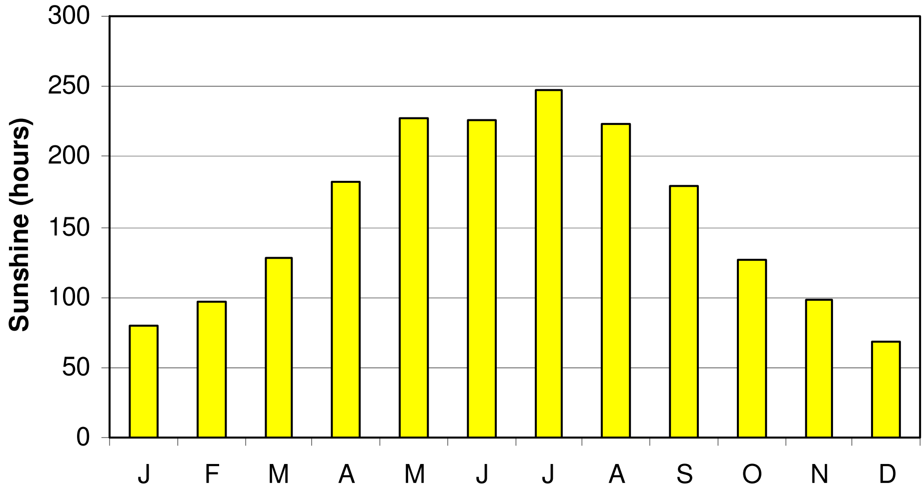


Figure 2.4: Mean monthly duration of sunshine hours at Weymouth for period 1997-2006 (Data from Weymouth & Portland Borough Council, 2007b)

The wind direction in coastal areas in the South West of England is predominantly from the southwest and the strongest winds nearly always blow from this direction (Met Office, 2007). Wind speeds are generally highest between November and March and lowest between June and August.

A wind rose showing the wind directions and speeds for a weather station at Wyke Regis (north west of Portland Harbour) is shown in Figure 2.5. The wind rose shows that the prevailing winds and those with speed over 11knots contain a west-southwesterly component. The potential effect of wind-driven currents on the way that levels of contamination impact on the BMPAs is discussed in Section 5.3.

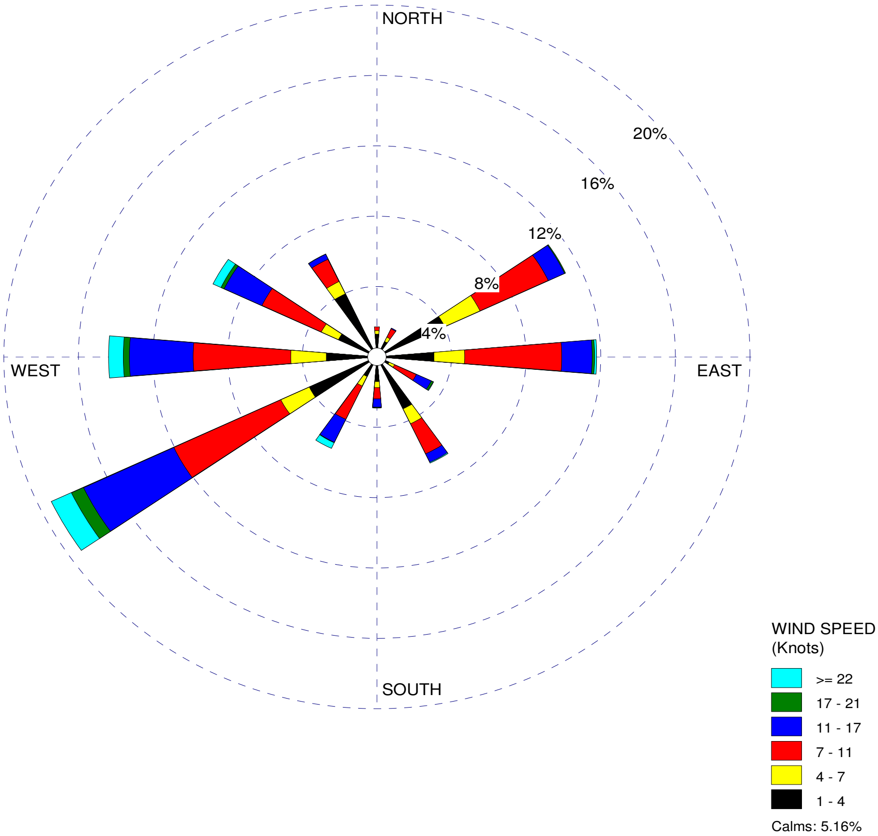


Figure 2.5: Wind rose for the period 1992-2007 at Wyke Regis near Weymouth (Based on daily (0900) observations provided by Robert Poots, W&PBC).

3. SHELLFISHERIES

Portland Harbour contains areas that are classified for the production of mussels (*Mytilus* spp.), Pacific oysters (*Crassostrea gigas*) and scallops (*Pecten maximus*). All existing beds within the harbour are currently classified as Class B under EC Regulation 854/2004. The enforcement aspects of this Regulation have been implemented via the Food Hygiene Regulations 2006 (SI 2006/14) as amended.

3.1 Several order fishery

A several order [Portland Harbour Fishery (Variation) order 1999] covers an area of 1.2km^2 in the southwestern side of the harbour (Figure 3.1). The fishery is designated under the Sea Fisheries (Shellfish Act) 1967 and grants exclusive fishing rights to the grantees in the defined area. The several order is currently managed by Hugh Wiltshire of Quest Holdings Ltd.

The several order bed is classified for the production of scallops (*Pecten maximus*). In both 1998 and 1999, 50,000 juvenile scallops were laid on the sea bed in the fishery (RPS, 2006). The scallops were deposited on the bed at a size at which they are relatively resistant to predation (about 60mm shell height) and left to grow to marketable size (100mm plus). The fishery was harvested by diving and provided a source of scallops in the winter when local boats were not always able to fish for wild scallops. The scallop fishery is not currently active due to issues of profitability relating to its shellfish hygiene classification (it is still sampled by diving for classification purposes however).

Quest Holdings are proposing to cultivate native (*Ostrea edulis*) and Pacific oysters (*Crassostrea gigas*) within the several order fishery and have sought classification of the fishery for both these species. The oysters will be grown in trays within a metal frame on the seabed (Photos 3.1 & 3.2). This operation is currently at a trial stage. The location of the trial cage is shown in Figure 3.1. The applicant requested classification for the entire several order bed. Anticipated annual production is not yet known.

The gastropod Abalone (*Haliotis tuberculata*) is also cultivated within the several order, although the species is not yet harvested commercially.

3.2 Mussel farms

There are two mussel farms in Portland Harbour at which mussels (*Mytilus* spp.) are farmed by suspended rope culture: one on the inside of the Outer Breakwater and the other on the inside of Bincleaves Breakwater Groyne (Figure 3.1). Harvesting at both farms occurs all year round.

The farm at Bincleaves Breakwater is operated by Lyme Bay Shellfish Limited. This farm covers an area of approximately 120,000m^2 and holds fourteen ropes each with one hundred drop down lines (Photo 3.3). The farm produces 800 kilograms of mussels a week (RPS, 2006). The site is also classified for the production of Pacific oysters (*Crassostrea gigas*) which are grown in lantern nets suspended from longlines at a depth of 2 to 5 metres (Photo 3.4).

Lyme Bay Shellfish are proposing to move their operation to a site inside the North Eastern Breakwater (Figure 3.1), and classification of this site for the production of mussels and pacific oysters has been requested.

The farm inside the outer breakwater covers an area of approximately 100,000m^2. Information gathered by RPS (2006) indicates that the operator was recently farming 2 lines, each of which can produce 10 tonnes of mussels per year; although there is the possibility to farm up to 10 lines with a production of 100 tonnes of mussels per year.

Photo 3.1: Metal bed frame with trays for cultivation of native oysters

Photo 3.2: Bed frame with native oysters being raised in several order

Photo 3.3: Mussel ropes at Bincleaves Groyne

Photo 3.4: Pacific oysters in lantern net at Bincleaves Groyne

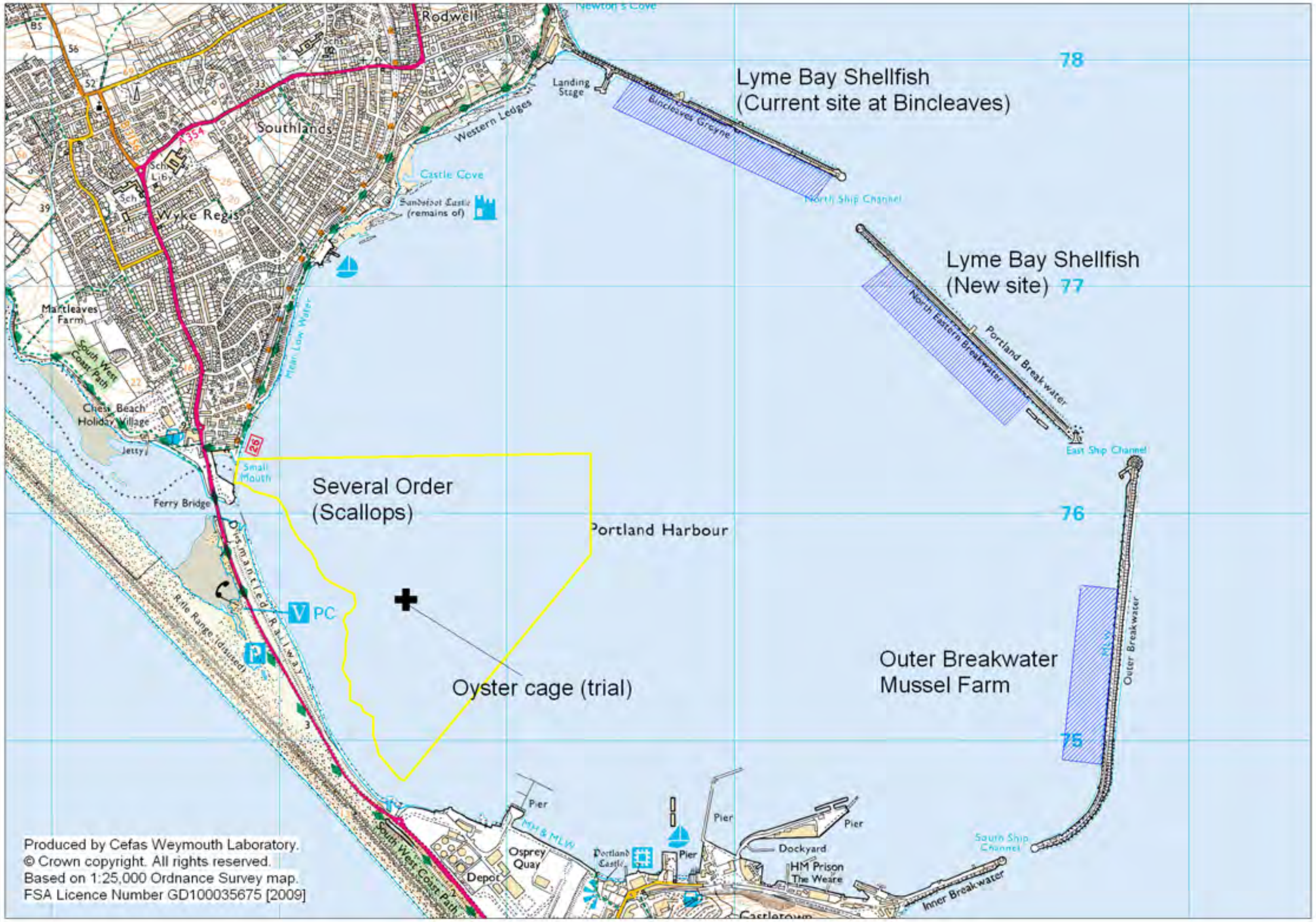


Figure 3.1 Shellfish beds in Portland Harbour

4. INVENTORY OF POLLUTION SOURCES

4.1 Sewage discharges

Sewage from Weymouth and Portland is treated at Weymouth sewage treatment works (STW) (Population equivalent=116,604) and biologically treated effluent is discharged to Chesil Cove in Lyme Bay from an outfall 1.3km off Chesil Beach. Consequently, there are no significant continuous sewage discharges directly into Portland Harbour. There are a number of intermittent sewage discharges (combined sewer overflows (CSOs) and sewage pumping stations (SPSs) that discharge directly in the harbour in the event of a storm or emergency spill (Table 4.1 and Figure 4.1). None of these discharges is thought to spill frequently and the aggregated predicted spill frequency for discharges to the harbour has been assessed as 7 spills of greater then 50 m^3 per year at the present time (Wessex Water, 2007). Of the discharges listed in Table 4.1, only Wyke Castle Cove SPS has spill monitoring equipment installed. Telemetry has alarmed on overflow on five occasions between November 2006 and February 2007, although only two to four of these spills are thought to be significant (i.e. exceed $50m^3$) (Wessex Water, 2007).

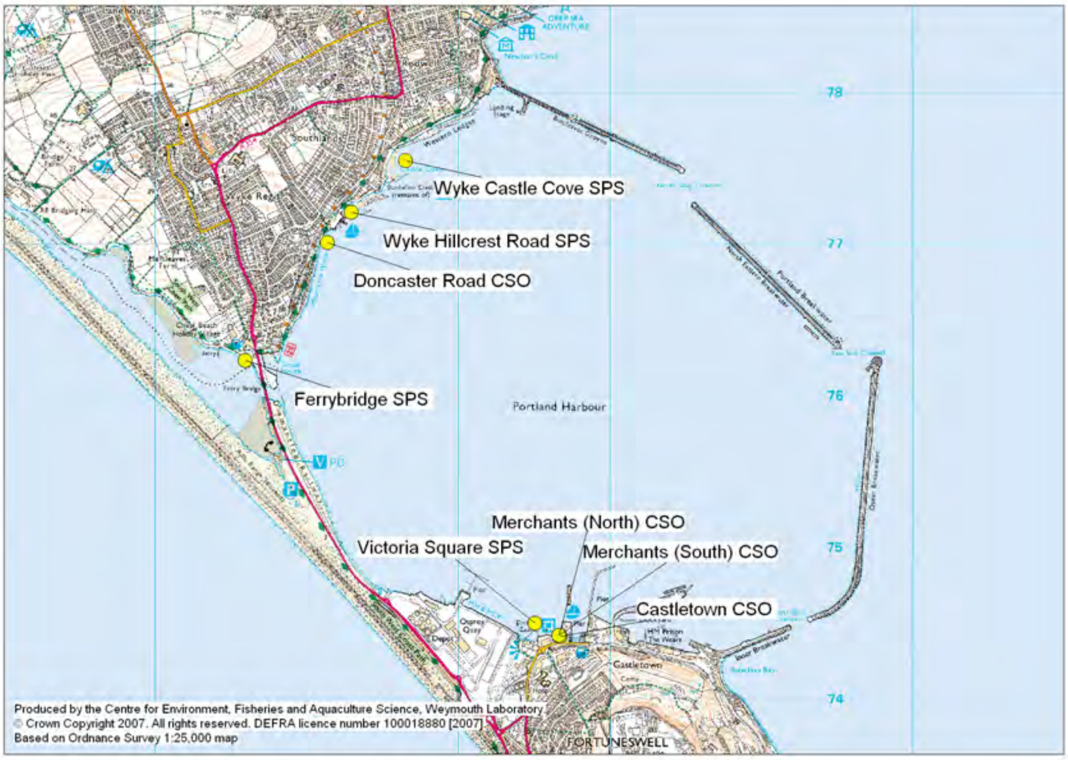


Figure 4.1: Locations of intermittent discharge outfalls to Portland Harbour

A storm sewage overflow from HM Prison The Verne is located outside the harbour at NGR SY 7002 7332, 0.7km from the South Ship Channel. There are no known problems associated with this discharge (Environment Agency, personal communication). In addition, there are a number of intermittent sewage discharges to Weymouth Harbour and Weymouth Bay that have the potential to influence water quality in Portland Harbour (Environment Agency, 2007a,b). These are listed below in Table 4.2. Several of these assets are believed to spill frequently and the aggregated predicted spill frequency has been assessed as 24 spills of greater then 50m^3 per year at the present time (Wessex Water, 2007).

Table 4.1: Intermittent sewage discharges to Portland Harbour
(Data from Wessex Water Services Ltd., 2007).

Discharge name	NGR of discharge	Predicted spill frequency per year (>50m^3)	Maximum PFF (l/s)
Doncaster Road CSO	SY 6713 7701	1	140
Portland Castletown CSO	SY 6867 7441	Nil	N/A
Portland Merchants (South) CSO	SY 6866 7442	Nil	N/A
Portland Merchants (North) CSO	SY 6866 7442	Nil	N/A
Wyke Hillcrest Road SPS	SY 6729 7721	Nil	237
Wyke Castle Cove SPS	SY 6765 7755	5	30
Ferrybridge Portland Road SPS	SY 6659 7623	Nil	68
Portland Victoria Square SPS	SY 6850 7450	6	480

CSO = Combined Sewer Overflow, SPS= Sewage Pumping Station, PFF= Pass forward flow, N/A Not applicable. N.B. Ferrybridge SPS discharges to the Fleet but is included here because of its proximity to the harbour.

Table 4.2: Intermittent sewage discharges to Weymouth Harbour and Weymouth Bay
(Data from Wessex Water Services Ltd., 2007)

Discharge name	NGR of discharge	Predicted spill frequency per year (>50m^3)	Maximum PFF (l/s)
Roman Road (New) CSO	SY 6726 8134	11	24
Spa Road CSO	SY 6721 8097	Nil	N/A
Ullswater Crescent CSO	SY 6721 8097	2	105
Coronation Cresc o/s No3 CSO	SY 6721 8097	Nil	38
Grasmere Road CSO	SY 6713 8094	Nil	135
Longcroft Queensland CSO	SY 6758 7873	7	30
Knightsdale Tank CSO	SY 6758 7873	19	44
Chickerell Rd nr Admiral Hardy CSO	SY 6758 7873	16	-
Weston Road CSO	SY 6758 7873	Nil	53
Chickerell Road CSO	SY 6758 7873	8	65
Chickerell Road Boys Club CSO	SY 6758 7873	Nil	96
Marlow Road CSO	SY 6806 7862	1	25
Rodwell Avenue CSO	SY 6806 7862	4	101
Spring Lane CSO	SY 6806 7862	Nil	158
Spring Rd CSO (nr jun with Mount St)	SY 6806 7862	0.3	158
Spring Road (o/s 1 Brewers Quay)	Unknown	3	157
Wardcliffe Road CSO	SY 6758 7873	Nil	N/A
Newstead Road CSO	SY 6758 7872	0.4	144
Weymouth Radipole SPS	SY 6766 7921	3	2200
Melcombe Avenue CSO	SY 6870 8058	2	50-55
Cranford Avenue CSO	SY 6870 8058	20	25

CSO = Combined Sewer Overflow, SPS= Sewage Pumping Station, PFF= Pass forward flow.

There are several small continuous sewage discharges to the Fleet but due to their size and distance from the harbour they are unlikely to represent a significant source of bacterial contamination of shellfisheries in the harbour.

Seasonal variation in visitor numbers to Weymouth (Figure 2.2) is reflected in the design criteria for the sewerage infrastructure. The design flows and loads for Weymouth STW are given in Table 4.3. Summer biochemical oxygen demand (BOD) design loads (for 2012) are approximately 1.25 times the winter design loads.

Table 4.3: Summary of design loads and flows for Weymouth STW (Data from Wessex Water Services Ltd.)

	From Revised Flows & Loads Spreadsheet		**Original Design Data**
Year	2012	2027	2040
Summer Populations			
Resident	71,591	77,144	-
Non-resident	20,115	21,678	-
Commercial	3,597	3,876	-
Sub total	95,303	102,698	136,640
Peak day visitors	75,000	75,000	-
Total population	170,303	177,698	136,640
Winter Populations			
Resident	71,591	77,144	-
Non-resident	6,035	6,503	-
Commercial	3,597	3,876	-
Sub-total	81,222	87,523	97,580
Peak day visitors	15,000	15,000	-
Total population	96,222	102,523	97,580
Consented Flows			
DWF (m^3/d)	32,141	32,141	32,141
FFT (m^3/d)	77,760	77,760	77,760
Calculated Flows			
DWF (m^3/d)	21,381	22,965	35,940
FFT (m^3/d)	53,498	57,785	77,760
Summer Loads			
BOD load (kg/d)	7,327	7,892	9,653
Ammonia-N load (kg/d)	1,201	1,278	1,332
Winter Loads			
BOD load (kg/d)	5,852	6,348	6,894
Ammonia-N load (kg/d)	841	909	951

BOD=Biochemical oxygen demand, DWF=Dry Weather Flow, FFT=Flow to Full Treatment

4.2 Ships and boats

Until 1996 Portland Harbour was an important naval base. Since the departure of the Royal Navy a commercial port has developed, offering access for vessels of up to 20m draft in the outer harbour (Weymouth Bay outside of the breakwaters) and up to 12m draft in the inner harbour. The port typically has over 300 commercial vessel calls (i.e. vessels over 50m length over all) per year (2003 figures, Portland Harbour Authority website). In addition, there are around 84 registered fishing boats operating from Weymouth and Portland (Walmsley and Pawson, 2007), although the majority of these boats are based in Weymouth Harbour.

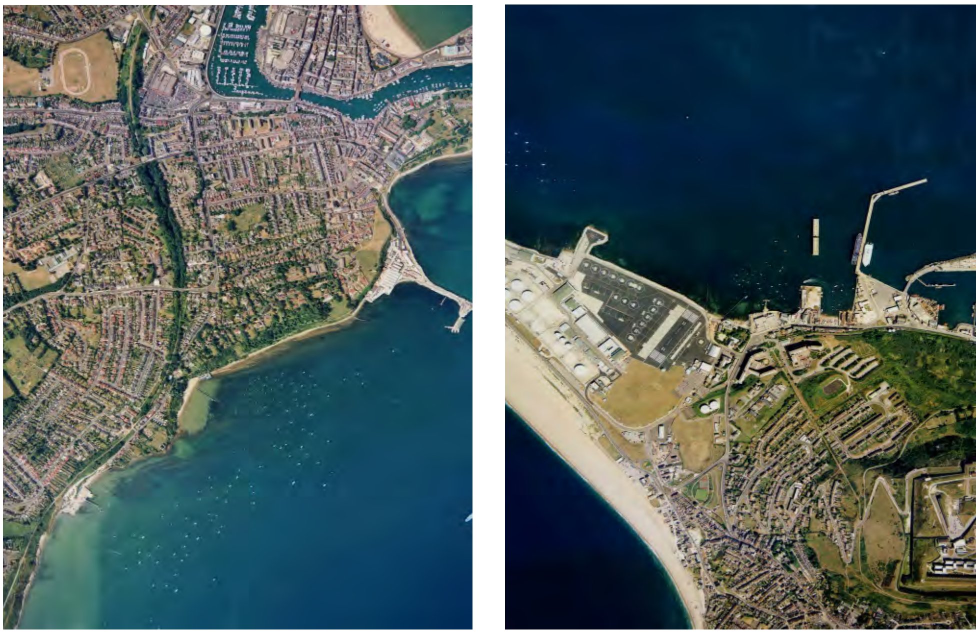


Figure 4.2: Aerial photographs (summer 1997) showing small boat moorings off a) Castle Cove and b) Osprey Quay © Dorset County Council 2000

Portland Harbour and the immediate area are a very popular sailing venue for visiting and resident yachts. A limited number of visitor moorings are currently available in Portland Harbour and the majority of yachts visiting the area stay overnight in Weymouth Harbour. Weymouth Harbour has approximately 1000 resident small craft and receives around 6000 visiting craft per year (Weymouth & Portland Borough Council 2007a). Seasonal variation in numbers of leisure craft visiting Weymouth Harbour (visiting boat nights) in 2006 and 2007 is shown in Figure 4.3. The number of visiting boats peaks in August.

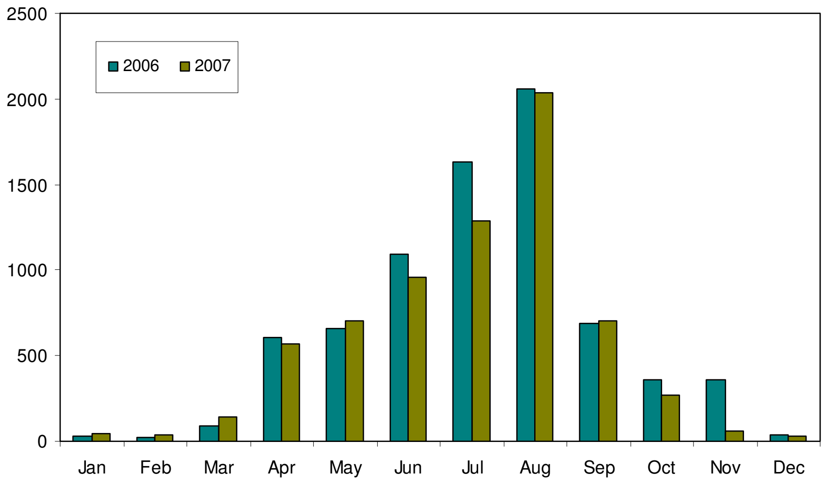


Figure 4.3: Seasonal variation in numbers of visiting leisure craft (power and sail) to Weymouth Harbour, 2006-2007 (Data from Dennis George, WPBC)

Visitor moorings are located both in the outer harbour and in Weymouth Marina in the inner harbour. Within Portland Harbour, seasonal (April to October) small boat moorings are located off Castle Cove and Osprey Quay

(Figure 4.2). No sewage pump-out facilities are currently available in either Portland or Weymouth Harbour and there is a risk of bacterial contamination in the harbour from the discharge of sea toilets. There is, however, a byelaw prohibiting the discharge of any matter into the harbour (The Portland Harbour Revision Order 1997) and the discharge of sea toilets within enclosed waters is discouraged.

A 600-berth marina is being developed within Portland Harbour at Osprey Quay, adjacent to Weymouth and Portland Sailing Academy. The site extends into the southern part of the several order scallop bed by some 200m and could potentially be a source of contamination of this bed. The breakwater enclosing the marina was completed in August 2008 and the marina is expected to offer berths from 2009. Sewage pump-out facilities will be provided (Dean & Reddyhoff, 2008). In addition, there are proposals to develop a 150-berth marina outside of the harbour off the Pavilion site in Weymouth Bay (Howard Holdings Plc., 2007).

4.3 Birds

Bird species commonly observed throughout the year in Portland Harbour and its vicinity include cormorants and various species of gulls (Dorset Bird Club, 2007). Maximum counts of herring and black-headed gulls in the harbour in 2005 were 2,500 and 1,070 respectively (Dorset Bird Club, 2007).

The harbour is of limited value to breeding birds due to a lack of suitable nesting sites. Several species breed on the northeastern breakwater including herring (~5 pairs), lesser black-backed (1-2 pairs) and greater black-backed gull (~5 pairs), oystercatcher, common tern and rock pipit (Portland Harbour Authority, 2006; Dorset Bird Club, 2007). Faecal material from birds roosting or nesting on the breakwaters and associated buildings may be washed into the harbour following rainfall, although there is no evidence that this is a significant source of contamination. The harbour is more important as an over-wintering site for wildfowl (notably red-breasted merganser, brent goose and cormorant), although individual species are not usually present in particularly high numbers (Royal Haskoning, 2007).

The Fleet lagoon supports much larger numbers of wintering wildfowl and could be a source of faecal contamination of shellfisheries in the harbour in the winter months. Brent goose, mute swan, widgeon and coot are particularly important in terms of numbers of individuals (Banks *et al.*, 2006). The Fleet also has a large resident population of mute swans; with up to 930 individuals recorded in the summer at the biennial swan round up at Abbotsbury Swannery (Chesil Bank and the Fleet Nature Reserve, 2005). Radipole Lake, an RSPB reserve located north of Weymouth Harbour, supports large numbers of resident and migratory birds including gulls, geese, ducks, swans and cormorants (Dorset Bird Club, 2007). Seasonal variation in numbers of key species in the Fleet and Radipole Lake is given in Table 4.4. Peak counts for all species listed are highest in the winter months (October to February).

Table 4.4 Monthly maximum counts of key bird species in a) the Fleet and b) Radipole Lake in 2005 (Dorset Bird Club, 2007).

a) The Fleet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mute Swan	750	779	758	593	753	804	998	855	1087	1081	1097	878
Brent Goose	300	280	170	15					1	1500	2000	3000
Widgeon	1384	994	774	2	0	0	0	30	837	6100	1200	3000
Coot	800	1550	300					100	600		1100	2000
Mallard	439	329	382	230	231	402	500	500	450	632	764	661
Pochard	610	270	255	10	0	6	8	5	37	243	340	625
Teal	500	150	160	39	4	2	0	110	365	271	34	564
Pintail	328	318	228	2	0	0	0	0	70	117	1	267
RB Merganser	255	136	182	246	0	0	0	0	0	20	8	270
Tufted Duck	132	85	120	110	18	32	7	35	160	193	131	260
Shoveler	90	92	42	2	0	0	3	16	41	27	47	150

b) Radipole Lake

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BH gull	500	1000	409	8	1	4			60	220	770	250
Herring gull	150	300	145	111	146	54		250	16	160	237	135
Mallard	200	350	200				300	400	185	450	300	160
Pochard	210	37	32	6	2	13	16	20	0	43	99	106
Tufted duck	103	100	65	40	10	11	11	35	12	48	85	48
Cormorant	14	11	16	4	7	11	19	23	24	33	21	3
Coot	70	60	65		12	10		35	47	95	57	80

N.B. Underlined values indicate yearly maxima.

4.4 Farm animals

There is no farmland immediately adjacent to Portland Harbour. The Fleet and River Wey have agricultural catchments and diffuse faecal inputs from farm animals (predominantly sheep and cattle) and slurry spreading may impact on bacterial water quality in these water bodies. It is unlikely however that farm animals represent a significant source of bacterial contamination of shellfisheries within Portland Harbour and farm animals have not been considered further in this assessment.

4.5 Other sources

Dogs are exercised along the shore of Portland Harbour between Castle Cove and Chesil Beach Visitor Centre and dog faeces are a potential source of contamination of the production area. There are no dog bans in place.

5. HYDROGRAPHY AND HYDRODYNAMICS

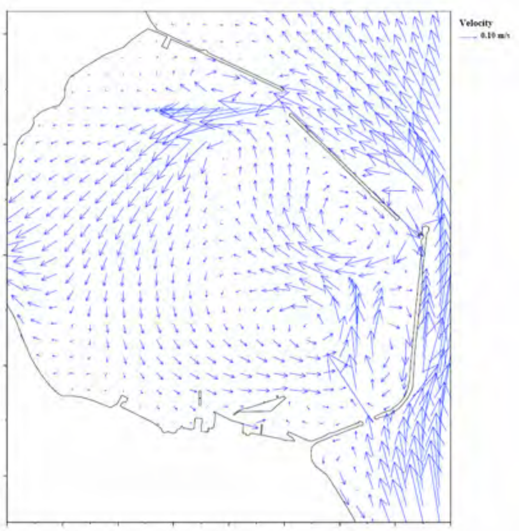
5.1 Tidal Currents

Flows in the harbour are predominantly in an anticlockwise direction, although there are clockwise flows in the vicinity of Coaling Pier and several areas of back-eddies (Portland Port Ltd, 2000). HR Wallingford (2007a) developed a tidal flow model of the harbour using the TELEMAC-2D hydrodynamic model. Model output for representative ebb and flood flows for a spring tide are presented in Figure 5.1. A general anticlockwise flow is modelled in the harbour at both of these times. A complex pattern of currents is evident however, with eddies on a range of spatial scales. The strongest currents are observed in the ship channels and the entrance to the Fleet. Away from the harbour entrances the peak current speeds are generally less than 0.2m s^{-1}.

The following observations can be made regarding the direction of depth-averaged flows in the vicinity of shellfish beds in the harbour:

- Flows move across the several order scallop bed in an anticlockwise (south easterly) direction on both ebb and flood tides.
- Flows move through the mussel farm at Bincleaves Breakwater in an easterly direction on both ebb and flood tides.
- Flows move through the mussel farm at the Outer Breakwater in a southerly direction on flood tides and a northerly direction on ebb tides.

a) flood



b) ebb

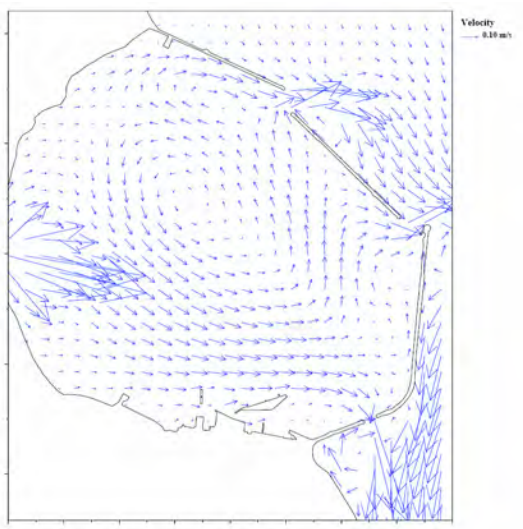
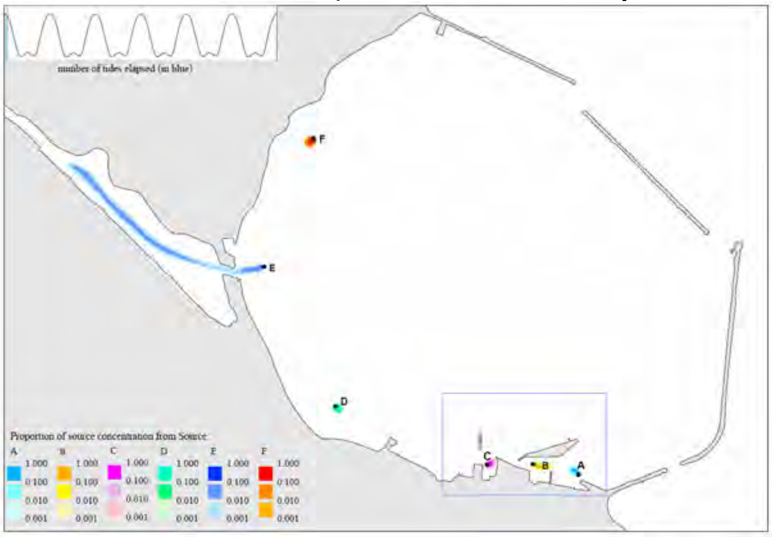


Figure 5.1: Modelled tidal flow vectors in Portland Harbour for a) flood and b) ebb tide. *(N.B. These figures are reproduced with the consent of HR Wallingford Limited, the copyright owner. HR Wallingford will accept no liability for the use of information contained within these figures by third parties.)*

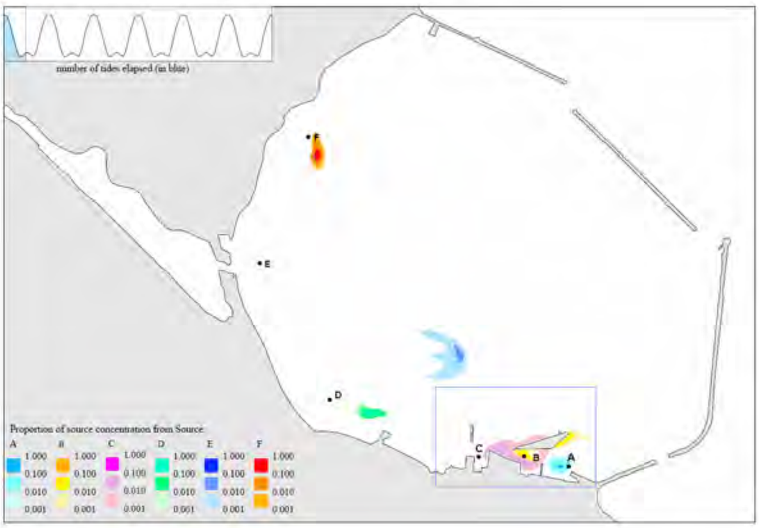
HR Wallingford applied a dispersion model (PLUME-RW) to the tidal flow model output to assess the level of flushing in the harbour. Six distinct particle sources were released in the modelled flow field from six locations in the harbour (Figure 5.2). The particles were released at high water for a period of one hour and the model was run for six repeating spring tides. Particles from source D are flushed slowest, and some remain in the harbour after six tides. Particles from sources E and F are flushed most quickly, moving into and out of the Fleet. With the exception of Source D, which remains near the bank, all tracers are eventually reduced to a concentration of less than 0.1% of their source concentration after six tides.

Figure 5.2: Distribution of simulated tracer releases in Portland Harbour over six tides (HR Wallingford, 2007a). *(N.B. These figures are reproduced with the consent of HR Wallingford Limited, the copyright owner. HR Wallingford will accept no liability for the use of information contained within these figures by third parties)*

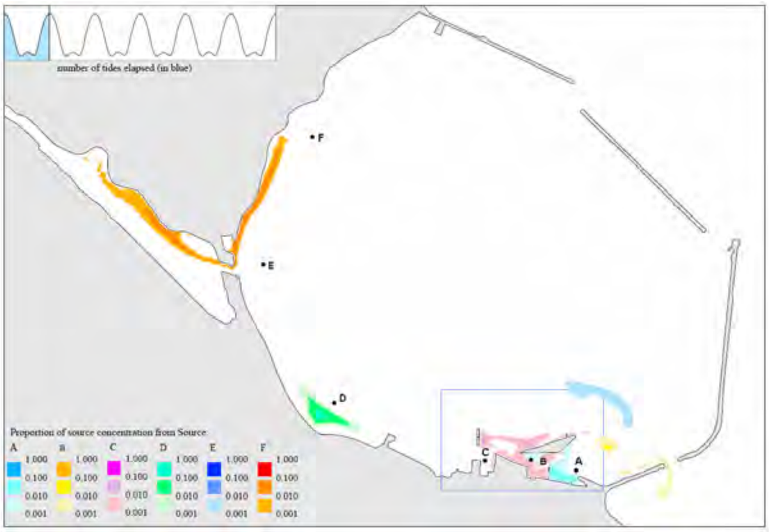
a) Distribution of tracers after one hour (letters A to E indicate point of tracer release)



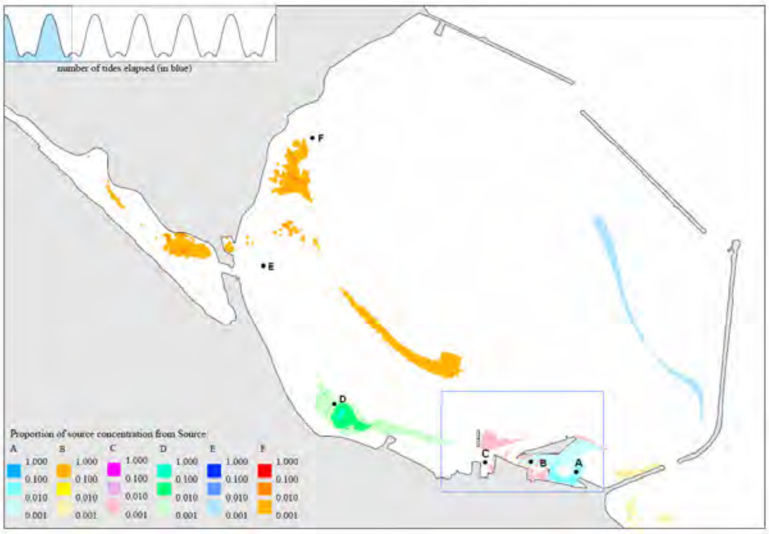
b) Distribution of tracers after half a tide



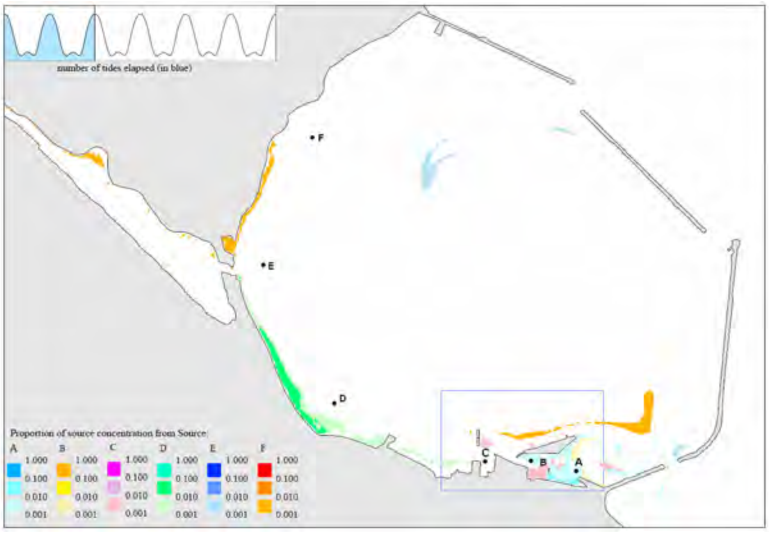
c) Distribution of tracers after one tide



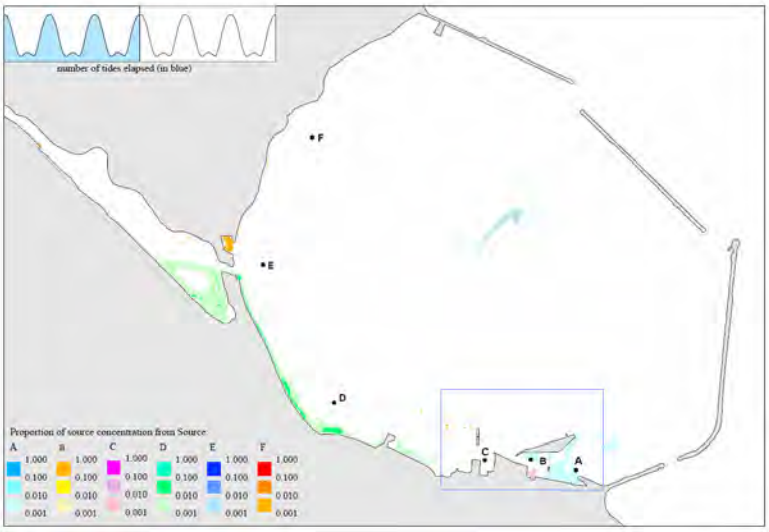
d) Distribution of tracers after one and a half tides



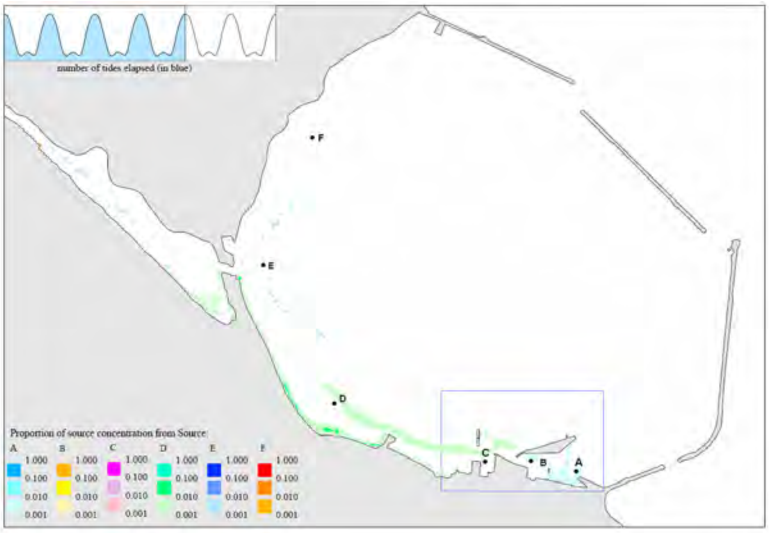
e) Distribution of tracers after two tides



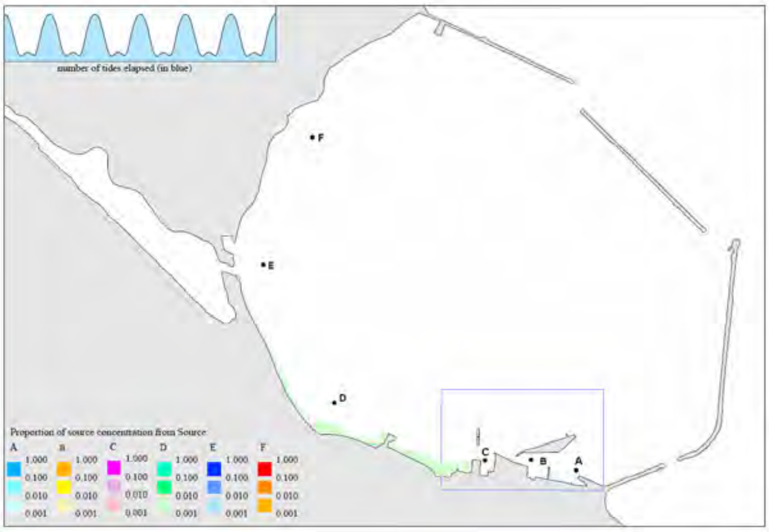
f) Distribution of tracers after three tides



g) Distribution of tracers after four tides



h) Distribution of tracers after six tides



The following conclusions can be made in relation to the impact of discharges on shellfisheries in the harbour:

- The simulated releases from sources A, B and C can be used to assess the impact of discharges from within Portland Port. These sources are gradually flushed from the port area and do not appear to impact significantly on any of the shellfisheries in the harbour.

- The release from source F can be used to assess the impact of a sewage spill from the outfalls at Sandsfoot Castle or Castle Cove. After moving in and out of the Fleet, contamination from this source travels across the several order bed in a southeasterly direction. No other beds are impacted.

- The release from source E can be used to assess the impact of contamination from the Fleet (e.g. faecal contamination from birds or a sewage spill from Ferrybridge SPS). As with source F, after moving in and out of the Fleet, this source impacts on the several order bed. No other beds are impacted.

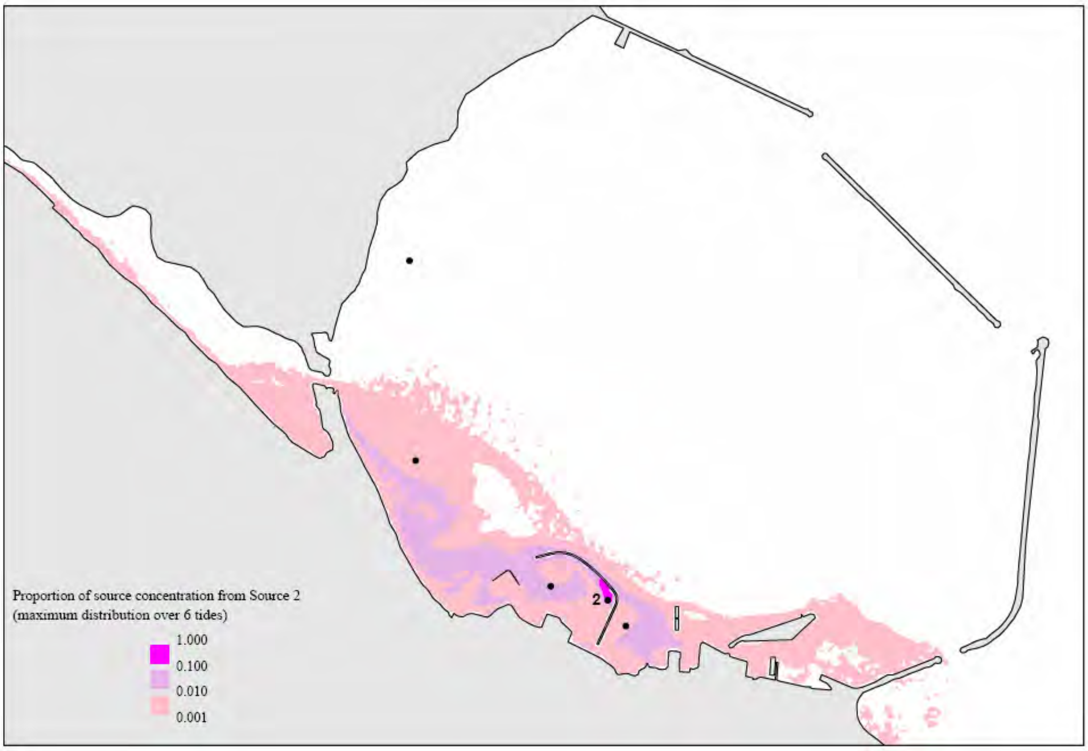
- The release from source D approximates to a release of contaminants from Osprey Quay, the site of a new 600-berth marina development. Contamination from this source is flushed slowly and may impact on the southern edge of the several order bed. No other beds are impacted.

5.2 Impact of the marina breakwater on tidal flows and plume dispersion

HR Wallingford (2007b) undertook further computational flow modelling using the TELEMAC model to assess the impact of Portland Marina and the surrounding breakwater on flows in the harbour. This assessment is of relevance due to the proximity of the marina to the several order bed and the potential for the marina to be a contamination source. The assessment demonstrated that the impact on flows is restricted to the local area around the development. At times approximately corresponding to peak ebb and peak flood, decreases in speed of up to -0.07m s^{-1} were predicted in areas sheltered by the breakwater and sailing academy wave screen. Small areas of increases speed were also predicted where flow is forced round or between structures.

Particle dispersion modelling showed a change in flushing regime in this part of the harbour. The simulated tracers released at high water near the marina were predicted to disperse more slowly in the slower flow field of the development area. Whereas for the existing layout, some tracer was leaving the harbour after one tide, it was now predicted to remain for longer, with significant amounts still remaining after four tides. The tracers released from two sites in the marina were predicted to spread over much of the southern part of the harbour, including the Several order bed (Figure 5.3), indicating that sewage discharged from boats in the marina could have a significant impact on these shellfisheries.

a) Site 2



b) Site 3

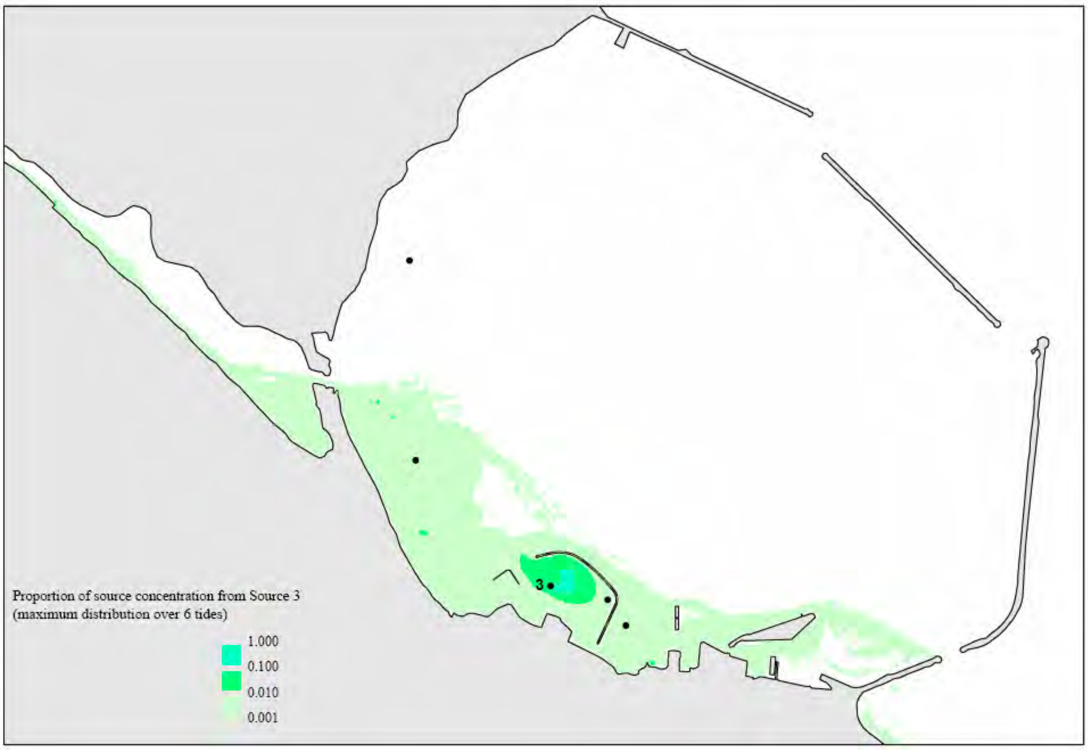


Figure 5.3: Maximum distribution (proportion of source concentration) of tracer released from two sites in the marina (sites 2 and 3) over six tides *(N.B. These figures are reproduced with the consent of HR Wallingford Limited, the copyright owner. HR Wallingford will accept no liability for the use of information contained within these figures by third parties)*

5.3 Wind driven currents

Because tidal currents in the harbour are generally quiescent, wind driven currents are likely to be important in the advection of contaminants in the harbour. Winds in the harbour are predominantly in a west or southwesterly direction and the strongest winds nearly always blow from these directions. Whilst it is difficult to predict the effect of wind on the direction of tidal currents within the harbour, particularly at depth, it is likely that sewage plumes at the surface of the water column would tend to be advected across the harbour in the direction of the prevailing wind. This suggests that on a strong west or southwesterly wind, sewage discharged from the intermittent discharges in the Castletown area would probably be advected towards the mussel farm at the Outer Breakwater. In contrast, sewage discharged from Sandsfoot Castle or Castle Cove outfalls (Wyke Regis) is more likely to be advected towards the mussel farm at Bincleaves Breakwater.

6. ANALYSIS OF MICROBIOLOGICAL DATA

6.1 Shellfish hygiene monitoring data

The locations of current and recently monitored shellfish hygiene monitoring points in and around Portland Harbour are shown in Figure 6.1. Samples are collected on a monthly basis by Weymouth Port Health Authority (Weymouth and Portland Borough Council) and analysed for *E. coli* by Wessex Environmental Microbiology Service (WEMS).

A summary of the *E. coli* data collected since 2002 (post sewerage improvements in the Wyke Regis area) is presented in Table 6.1. The majority of results for the sites within the harbour, and for the site in the Fleet, are less than 230 *E. coli* per 100g flesh (i.e. Class A), but there are sporadic results over 230 *E. coli* per 100g (Class B) and, occasionally, results over 4,600 *E. coli* per 100g (Class C). The highest levels of contamination (as measured by geometric mean and maximum *E. coli* result) are found at the oyster farm in the Fleet, suggesting that contamination sources in the Fleet may be the most significant sources of microbiological contamination of shellfisheries in the Portland Harbour area. The most recent results for the razor clam (*Ensis* spp.) bed in Weymouth Bay and for mussels at The Mixen have all been less than 230 *E. coli* per 100g indicating that levels of faecal bacterial contamination outside of the harbour are very low.

A single sample of native oysters collected from the bed cage within the Several order (Figure 3,1) on 26th May 2009 yielded an *E. coli* result of 230 per 100g (i.e. Class A).

The extent of contamination of bivalve molluscs grown on ropes can vary markedly with depth (Cefas, 2007). This may be due to, for example, stratification effects or resuspension of contaminated sediments from the bed. Between June 2000 and October 2001, parallel monitoring of mussels collected from the top and bottom of the mussel lines at the farm inside the Eastern (Outer) Breakwater (Bed B025J, Harbour SE ropes) was undertaken. The results are given in Table 6.2. No significant difference in geometric mean *E. coli* concentration for samples from the top and bottom of the lines was evident (paired two-sample *t*-test of $\log_{10}$-transformed data, degrees of freedom=13, t=0.35). The highest result (430 *E. coli* per 100g) was recorded in mussels from the top of the ropes. This suggests that sampling at the top of the ropes or lantern nets should be protective of public health.

Monitoring of Pacific oysters in lantern nets at Bincleaves Breakwater has been undertaken since September 2007. Several paired samples have been collected from the top and bottom of the nets as part of a bacteriological survey (Table 6.3). Although no systematic difference was evident in levels of contamination of oysters collected from the top and bottom of the nets, the highest result (750 *E. coli* per 100g) was recorded in oysters from the top of the nets. Again, sampling at the top of the ropes or lantern nets should be protective of public health.

Figure 6.1: Shellfish hygiene monitoring points in and around Portland Harbour (Only sites monitored since 2002 are shown)

Table 6.1: Summary of E. coli data (MPN per 100g) for sites in and around Portland Harbour, 2002-2009

Bed Name	**Bed ID**	**Species**	**No. samples**	**Min**	**Max**	**Geometric Mean**	**%<4600**	**%<230**
Fleet Oyster Farm (C. g)	B025A	*C. gigas*	75	<20	9100	143	97	68
Harbour - Several Order (M)	B025F	*Mytilus* spp.	13	<20	500	61	100	85
Harbour - South-East.3 Ropes (M)	B025J	*Mytilus* spp.	67	<20	5400	81	99	79
Lyme Bay Shellfish	B25AB	*C. gigas*	32	<20	750	37	100	94
Lyme Bay Shellfish Co (Portland Harbour)	B25AA	*Mytilus* spp.	48	<20	5400	47	98	85
Scallop Bed, Several Order (Sc)	B025T	*P. maximus*	55	<20	1300	54	100	91
The Mixen (M)	B025X	*Mytilus* spp.	13	<20	500	30	100	92
Weymouth Bay (Ensis)	B025P	*Ensis* spp.	9	<20	160	35	100	100
Wyke Portland Harbour	B025W	*Mytilus* spp.	4	<20	40	20	100	100

Table 6.2 Comparison of hygiene results (E. coli per 100g) for mussels from the top and bottom of the ropes at the Eastern Breakwater
(Bed B025J, Harbour SE ropes)

Date	Top of line	Bottom of line
15/06/00	<20	20
28/06/00	70	290
06/07/00	50	<20
12/07/00	40	220
25/07/00	<20	<20
09/10/00	<20	20
26/10/00	<20	40
14/11/00	70	40
20/02/01	20	40
10/04/01	160	40
06/06/01	310	220
23/06/01	<20	<20
11/09/01	70	40
17/10/01	430	310

Table 6.3 Hygiene results (E. coli per 100g) for Pacific oysters from lantern nets at Bincleaves Breakwater

Date	Top of net	Bottom of net
25/09/07	70	-
02/10/07	40	-
09/10/07	40	-
16/10/07	<20	-
23/10/07	<20	<20
30/10/07	40	20
06/11/07	<20	<20
12/11/07	<20	20
20/11/07	750	40

Rain. The results of *t*-tests undertaken to investigate the effects of rainfall prior to sampling[3] on the *E. coli* concentrations in shellfish are presented in Table 6.4. Whilst there did appear to be a tendency for the geometric mean *E. coli* result to increase slightly at all sites following rainfall, these differences were not statistically significant. It is noteworthy, however, that the only *E. coli* result over 4,600 per 100g for mussels from Bincleaves Breakwater (Bed B25AA, Lyme Bay Shellfish) was recorded the day after moderately heavy rainfall (8th May 2006, 5,400 *E. coli* per 100ml, 14.5mm rain in previous 24 hours).

[3] Daily rainfall totals are reported from 09:00 to 09:00. Assuming that sampling occurs in the morning, rainfall reported for the day before sampling provides a good estimate of rainfall in the 24 hours prior to sampling.

Table 6.4: Results of t-tests to examine if there was a significant change in geometric mean (GM) E. coli concentrations (per 100g) when rain fell (threshold 0mm), and when more than 5 mm rain fell (threshold 5 mm), in the 24 and 48 hours prior to sampling

	Rainfall threshold 0mm					*Rainfall threshold 5mm*				
	No rain		**Rain**			**<5mm rain**		**>5mm rain**		
	n	***GM***	***n***	***GM***	***p***	***n***	***GM***	***n***	***GM***	***p***
Rainfall in 24 hours										
Several Order Bed	29	40	13	53	NS	37	40	5	88	NS
SE Harbour ropes	33	91	15	108	NS	43	94	5	110	NS
Lyme Bay Shellfish	18	35	10	70	NS	27	37	1	5,400	N/A
Rainfall in 48 hours										
Several Order Bed	23	41	19	47	NS	33	38	9	73	NS
SE Harbour ropes	23	76	25	118	NS	37	99	11	86	NS
Lyme Bay Shellfish	13	31	15	60	NS	24	34	4	247	N/A

N.B. Rainfall data for station at Weymouth (data from the Environment Agency). n=number of samples; NS indicates not significant at 95% confidence level (p<0.05), N/A indicates that the sample size was too small to undertake t-test. All t-tests were undertaken on logarithmically transformed data. Less-than results were given a value of half face value. Data are for period 2002-2007.

Tide. Shellfish hygiene samples are collected across the full range of tidal states in the harbour. The results of *t*-tests undertaken to investigate the effects of tidal state (spring vs. neap tide and ebb vs. flood tide) at time of sampling on the *E. coli* concentrations in shellfish are presented in Table 6.5. For the mussel farm in the south east of the harbour, geometric mean *E. coli* concentrations were significantly higher for samples collected on ebb tides than those collected on flood tides, and geometric mean *E. coli* concentrations were significantly higher for samples collected on spring tides than those collected on neap tides. Differences at other sites were not statistically significant. The effect of tide will depend on the location of the shellfish bed with respect to the source of contamination (Younger *et al*., 2003). It is interesting to note that the mussel farm in the south east of the harbour was the only site at which tidal currents were in opposite directions on ebb and flood tides (see Section 5.1).

Table 6.5: Results of t-tests to examine if there is a significant effect of tidal state (spring/neap and ebb/flood) at time of sampling on geometric mean (GM) E. coli concentrations (per 100g)

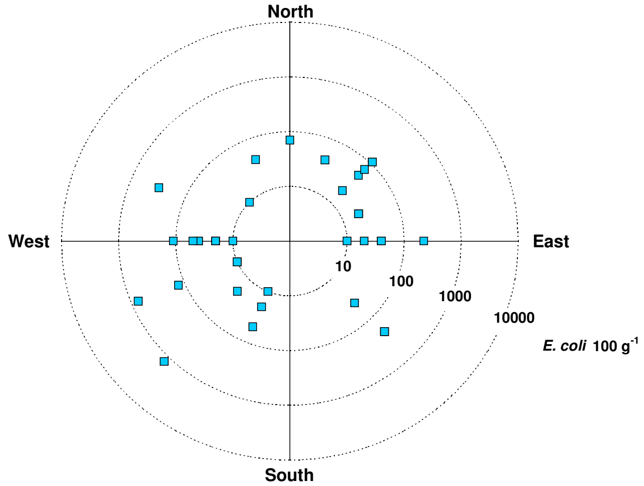
	State of tide					**Tidal range**				
	Ebb		**Flood**			**Spring**		**Neap**		
	n	***GM***	***n***	***GM***	***p***	***n***	***GM***	***n***	***GM***	***p***
Several Order Bed	32	48	14	50	NS	21	51	25	47	NS
SE Harbour ropes	30	125	21	54	0.036	20	154	31	62	0.042
Lyme Bay Shellfish	20	40	11	41	NS	12	37	19	42	NS

N.B. Tidal predictions for Portland from POLTIPS. n=number of samples; NS indicates not significant at p<0.05 level. All t-tests were undertaken on logarithmically transformed data. Less-than results were given a value of half face value. Data are for period 2002-2007.

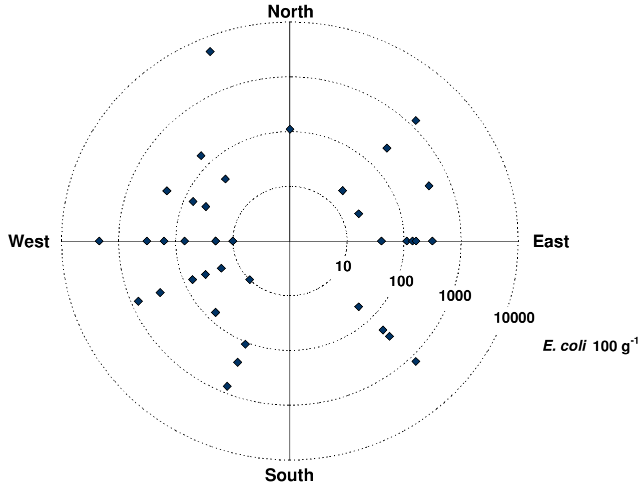
Wind. A scatterplot of *E. coli* results for shellfish hygiene monitoring sites in the harbour against wind direction on the morning of sampling is given in Figure 6.2. No clear patterns or differences between sites are evident and statistical analysis of this dataset has not been undertaken. As with tide, the effect of wind will depend on the location of the shellfish bed with respect to the sources of contamination. The average wind direction, deviation and speed over the period prior to sampling might be a more important factor in this context. Although wind-driven currents may modify the way that tides and currents take the contamination to the BMPAs, wind is not a legislative sanitary survey requirement. Therefore, it is beyond the scope of this study to investigate further.

Season. Lee and Morgan (2003) undertook a preliminary investigation on the environmental factors affecting the microbiological contamination of three BMPAs in England and Wales and concluded that season is one of the main factors determining the levels of *E. coli* in commercially harvested bivalves. Seasonal variation in levels of *E. coli* contamination at harvesting sites within the harbour is shown in Figure 6.3. Statistically significant effects were detected at two sites (Harbour South East ropes and Several Order Scallop Bed) and geometric mean levels of *E. coli* were highest in the spring at all sites. These effects could be due to a number of factors acting independently or in conjunction (Younger et al., 2003). These include biological variation in the activity of the shellfish, seasonal variation in pollutant loads from human or animal sources, and seasonal variation in levels of rainfall and sunshine.

a) Several Order Scallop Bed (B025T)



b) Harbour SE Ropes (mussels) (B025J)



c) Lyme Bay Shellfish (mussels) (B25AA)

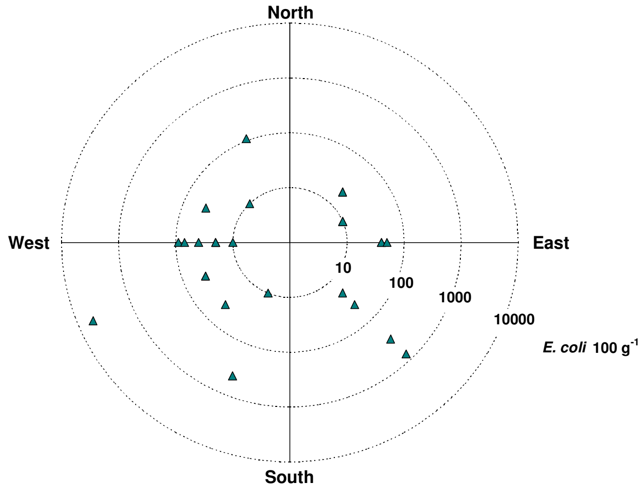


Figure 6.2 Scatter plots of wind direction against E. coli result, 2002-2007

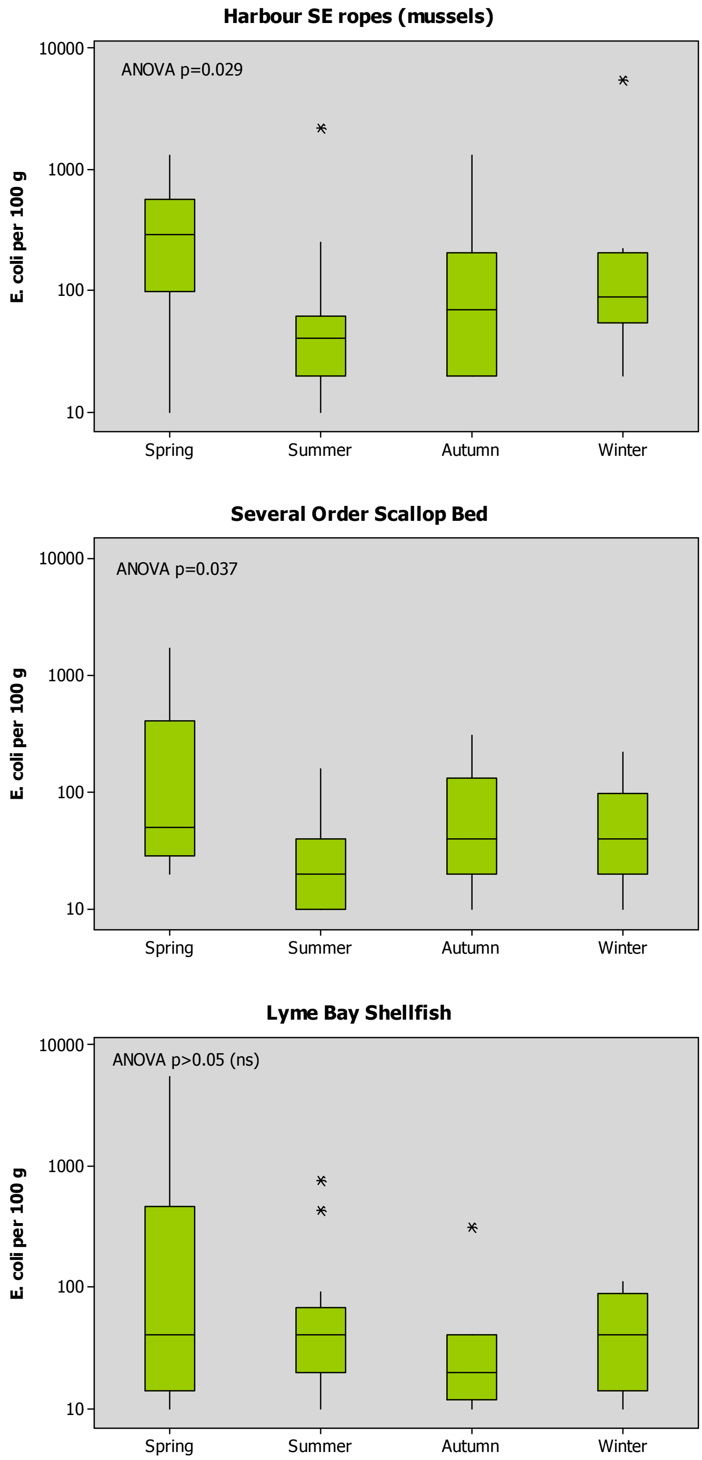


Figure 6.3: Box plots of seasonal variation in E. coli results, 2002-2007

N.B. *Spring (March-May), Summer (June-August), Autumn (September-November), Winter (December- February).*

6.2 EC Bathing Waters Directive monitoring data

Two beaches within Portland Harbour (Castle Cove and Sandsfoot Castle) are designated under the EC Bathing Waters Directive (76/160/EEC), and levels of faecal indicator organisms (total and faecal coliforms and faecal streptococci) are monitored weekly throughout the bathing water season (May to September) by the Environment Agency. The locations of the bathing water monitoring points are shown in Figure 6.4. Faecal coliform data for these sites, together with that for the beach at Weymouth, for the period 2003 to 2007 are summarised in Figure 6.5. There have been no breaches of the 'Imperative' (I) faecal coliform bathing water standard (2000 per 100ml) at any of the sites and results are generally within the 'Guideline' (G) bathing water standard (100 per 100ml). Whilst low throughout the bathing season, geometric mean faecal coliform counts are highest at all sites in August (Figure 6.6). It is suspected that this relates to direct contamination of the water by bathers and not to contamination from the sewerage infrastructure.

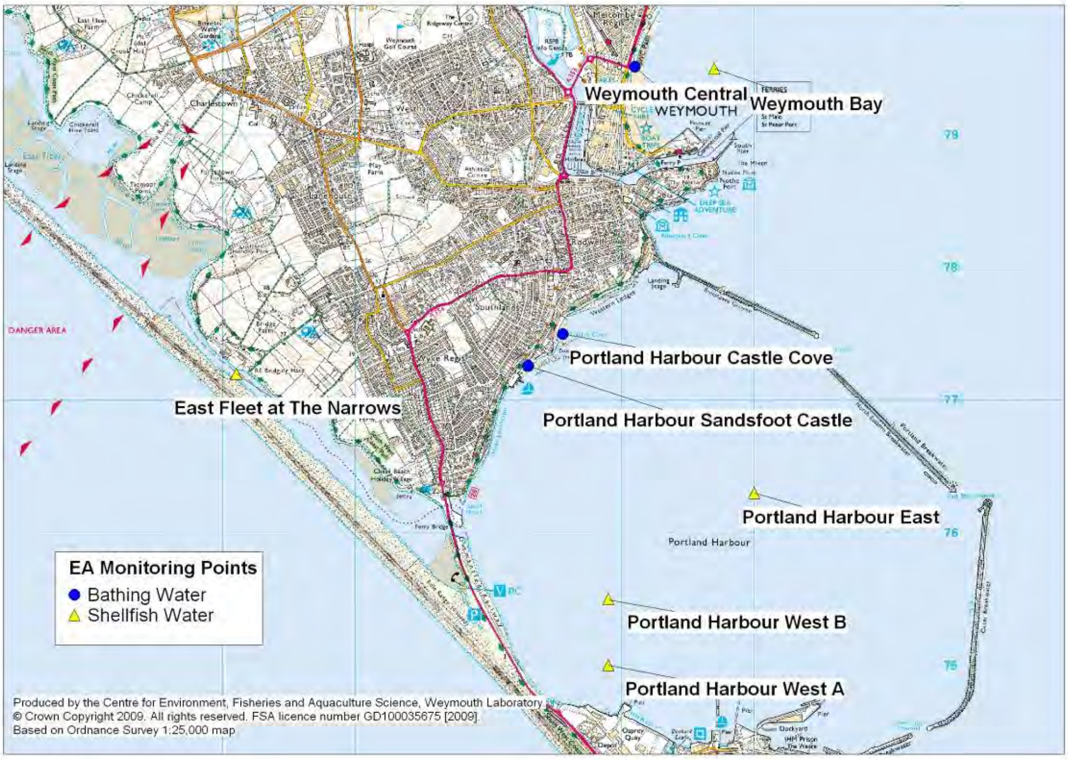


Figure 6.4: Locations of EC Bathing Water Directive and EC Shellfish Waters Directive water quality monitoring points in and around Portland Harbour

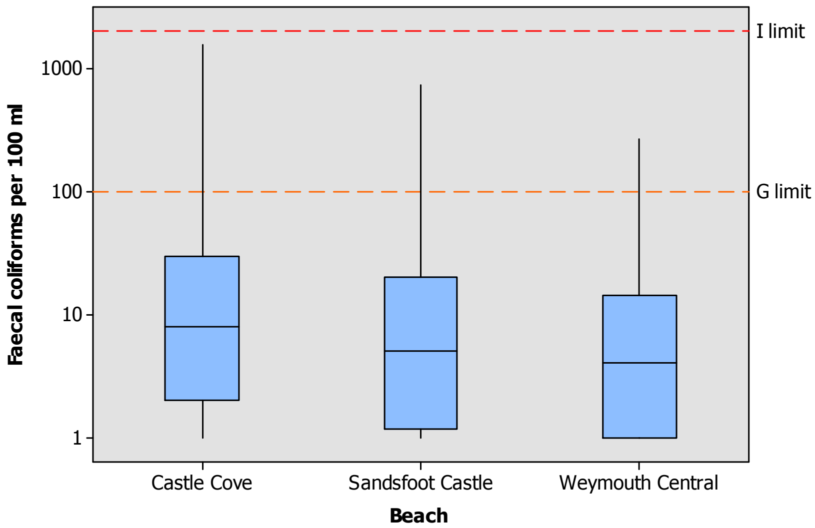


Figure 6.5: Boxplots of faecal coliform results (n=100) for bathing beaches in and around Portland Harbour, 2003 to 2007 (Data from Environment Agency)

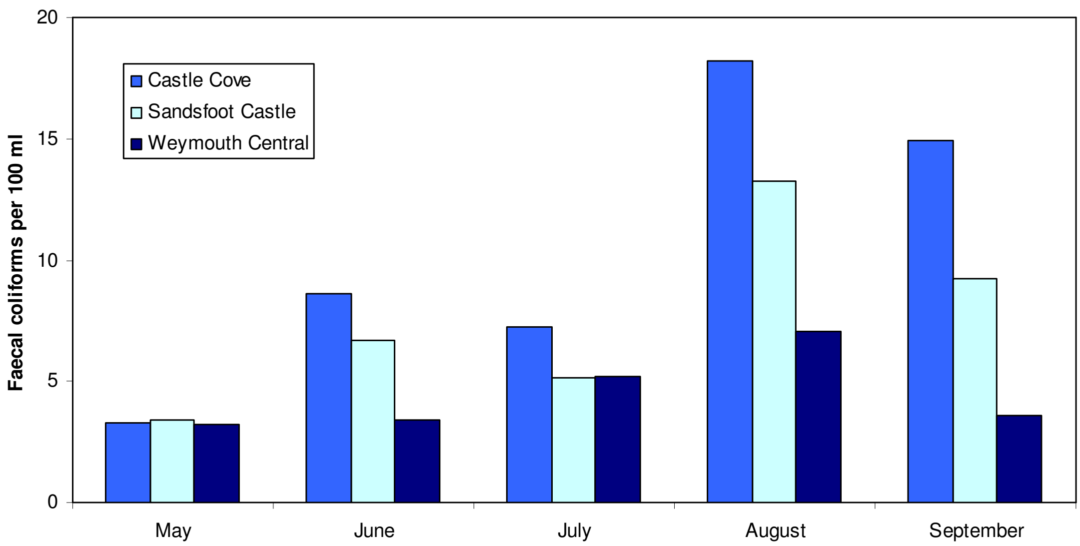


Figure 6.6: Monthly variation in geometric mean faecal coliform concentrations for bathing beaches in and around Portland Harbour (Data from the Environment Agency)

6.3 EC Shellfish Waters Directive monitoring data

Portland Harbour East and Portland Harbour West are designated shellfish waters under the EC Shellfish Waters Directive (79/923/EEC and 2006/113/EEC). Outside the harbour, The Fleet and Weymouth Bay are also designated Shellfish Waters. Levels of faecal coliforms (at the water surface) at these sites are monitored four times a year by the Environment Agency. The locations of the Shellfish Waters Directive water column monitoring points are shown in Figure 6.4. Data for the period 2002 to 2009 are summarised in Table 6.6. Over 50% of the results are below the reporting limit (<2 faecal coliforms per 100ml) at all sites, indicating that levels of faecal contamination in and around the harbour are generally very low. An outlier of 116 faecal coliforms per 100ml was recorded in Portland Harbour West monitoring point on 7th November 2005.

Table 6.6: Summary of faecal coliform data (number per 100ml) for shellfish waters in and around Portland Harbour, March 2002 to May 2009 (Data from the Environment Agency)

	Number of samples	Number of less-than	Median	Minimum	Maximum
Portland Harbour East	29	25	<2	<1	11
Portland Harbour West A	29	21	<2	<2	116
Portland Harbour West B[1]	5	5	<2	<2	<10
The Fleet	31	21	<2	<1	21
Weymouth Bay	20	16	<2	<2	20

[1]. Additional monitoring point introduced in 2008

An additional monitoring point (B) for the Portland Harbour West Shellfish Water was introduced in 2008 due to the proximity of the existing monitoring point (A) to the new marina at Osprey Quay (see Figure 6.4). Examination of recent (2008/09) data for both sites provides no evidence that the opening of the marina has resulted in increased levels of contamination within the shellfish water.

A limited number of shellfish flesh samples for faecal coliform analysis have also been collected from the harbour for Shellfish Waters Directive monitoring purposes. These data are less comprehensive than the *E. coli* data collected for shellfish hygiene classification purposes and are not presented here.

7. SHORELINE SURVEY

The aim of the shoreline survey was to confirm the presence of potential sources of microbiological pollution previously identified in a desk study and to identify any potential additional sources of contamination. Two separate shoreline surveys were undertaken:

Survey 1:	Bincleaves Groyne to Osprey Quay
Date:	29 August 2007
Time:	10:00 to 17:00
Surveyed by:	Carlos Campos (Cefas), Richard Acornley (Cefas)
Weather:	Dry, light winds
Tide:	Low water springs

Nigel Emery (Weymouth Port Health Authority) accompanied Cefas staff during the survey of Bincleaves Groyne, the site of the Lyme Bay Shellfish farm.

Survey 2:	Castletown to Balaclava Bay (including Portland Port)
Date:	23 January 2008
Time:	10:00 to 14:00
Surveyed by:	Richard Acornley (Cefas)
Weather:	Dry, light winds
Tide:	Low water springs

The areas surveyed are shown in the map in Figure 7.1.

An additional visit to the harbour was made on 20 November 2007 following heavy rainfall. This survey was undertaken to determine if any CSOs or other intermittent discharges were discharging to the harbour and also to collect samples from discharges for microbiological analysis.

Discharges identified during the shoreline surveys are listed in Table 7.1 and their locations are shown in the map in Figure 7.2.

7.1 Observations

No active discharges from Bincleaves Groyne (Lyme Bay Shellfish site) were found during the survey. No sewage or sanitary debris was found during either survey.

No CSOs were observed discharging sewage during the wet weather visit. Samples were collected from three surface water outfalls in the Wyke Regis area during wet weather. Results of microbiological analysis are given in Table 7.2. Whilst the results for all three surface water discharges in the Wyke Regis area are moderately high, they are typically of urban surface water run off and do not indicate that the discharges were grossly contaminated with sewage.

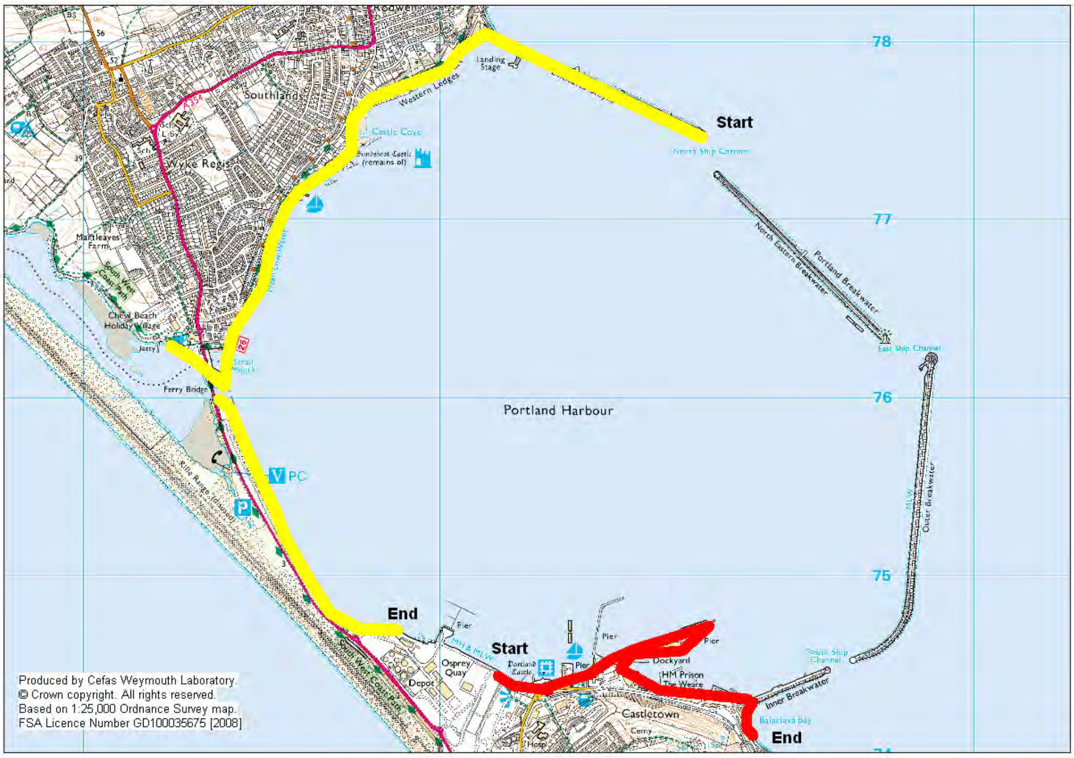


Figure 7.1: Area surveyed during shoreline surveys on 29 August 2007 (yellow line) and 23 January 2008 (red line)

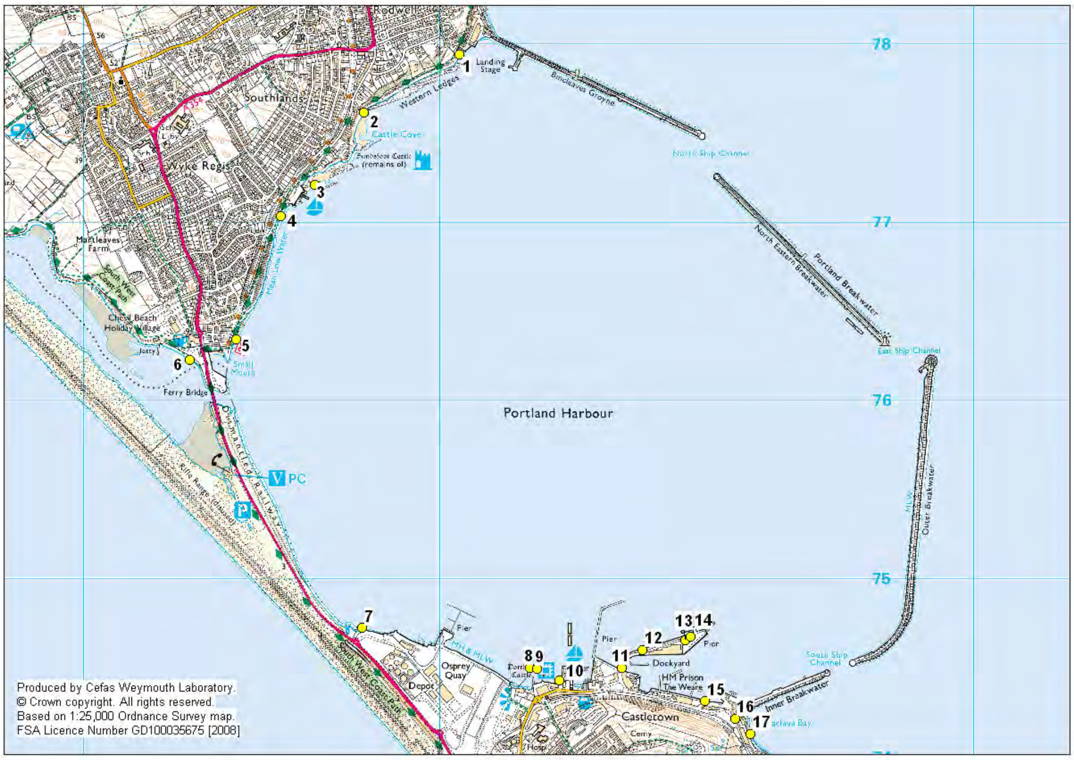


Figure 7.2: Discharges to Portland Harbour located during the shoreline surveys. See Table 7.1 for key

Table 7.1 Discharges located during the shoreline surveys. Numbers refer to map in Figure 7.2

No.	Location	NGR	Notes
1	Bincleaves	SY 68103 77942 From chart	Curved outfall with cross marker (Photo i). Outfall no longer in use.
2	Wyke Regis, Castle Cove	SY 67570 77620 From chart	Castle Cove outfall. Castle Cove SPS spills to this outfall
3	Wyke Regis, Sandsfoot	SY 67290 77210 From chart	Sandsfoot Castle outfall. Hillcrest Road SPS spills to this outfall
4	Wyke Regis	SY 67099 77034	Screened outfalls (Photo ii). Doncaster Road CSO spills to one of these outfalls. Faint smell of wastewater at time of visit. E outfall had greater flow than W outfall.
5	Wyke Regis	SY 66850 76344	Surface water outfall. Low flow at time of visit (Photo iii).
6	Ferrybridge	SY 66590 76230	Ferrybridge SPS (Photo iv).
7	Osprey Quay	SY 67560 74720	300 mm diameter pipe with flap valve (Photo v). No discharge. Suspected surface water outfall from storage tanks.
8	Castletown	SY 68499 74498 From chart	Outfall pipe visible at low tide. Cross marker. Victoria Square SPS spills to this outfall (Photo vi).
9	Castletown	SY68540 74490	Cross marker. Castletown outfall (Photo vii)
10	Castletown	SY 68669 74424	Merchants outfall (Photo viii). Under sea wall.
11	Coaling Pier Bridge	SY 69018 74494	Large diameter pipe. Probable surface water outfall (Photo ix)
12	Coaling Pier	SY 69132 74595	Toilet block with Klargester septic tank. Portland Port Ltd. have confirmed this is no longer in use and there is no discharge to harbour.
13	Coaling Pier	SY 69375 74650	Several pipes. Not discharging at time of visit. Probably surface water overflows from hard standing. (Photo x)
14	Coaling Pier	SY 69405 74673	Steel pipe discharging clear liquid. Possible wash basin outfall.
15	Portland Port	SY 69486 74312	Small screened surface water outfall
16	Balaclava Bay	SY 69654 74209 From chart	Outfall running across beach. No discharge (Photo xi).
17	Balaclava Bay	SY 69741 74125	Green pumping station kiosk with outfall to bay outside of harbour (Photo xii). Portland Port Ltd. confirmed that this is still in use and would discharge foul water in the event of an emergency.

Table 7.2: Results of microbiological analysis

Site	**NGR**	***E. coli* per 100 ml**
Wyke Regis SW outfall 1 W	SY 67099 77034	7,450
Wyke Regis SW outfall 2 E	SY 67100 77029	6,450
Wyke Regis SW outfall 3	SY 66850 76344	4,950

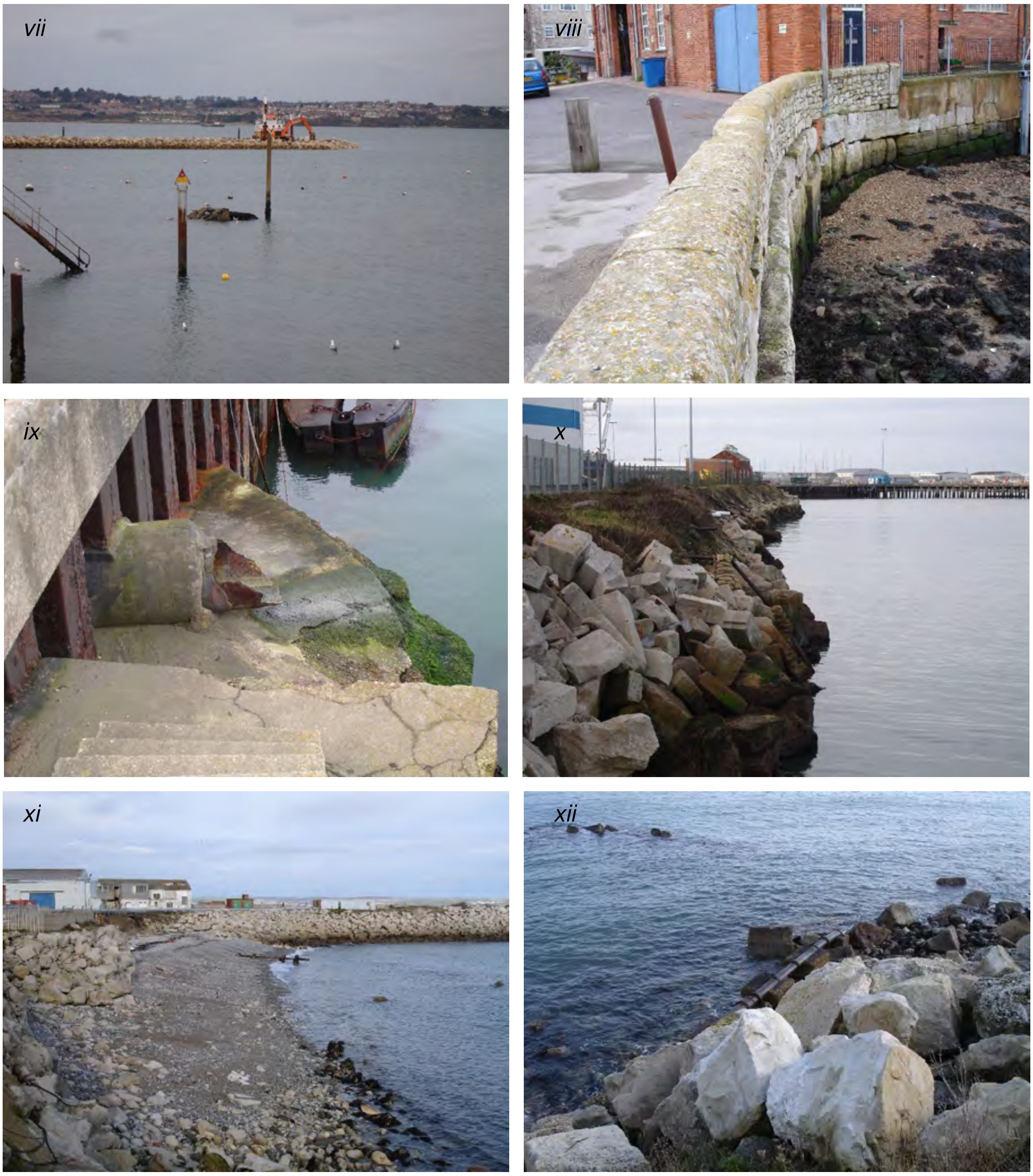
7.2 Conclusions

The shoreline survey has confirmed the presence of the intermittent discharges identified during the desk study.

Several surface water discharges were identified during the shoreline survey. Flows from these discharges during wet and dry weather were low and these sources are unlikely to represent significant sources of contamination of shellfisheries in the harbour.

The survey of the port area revealed several discharges that had not been documented in the desk study. The most significant of these was a sewage pumping station overflow that would discharge to Balaclava Bay 600 m from the South Ship Channel. Portland Port Ltd. have since confirmed that this pumping station is operational and foul water would be discharged in the event of an emergency. Although no event duration data are available, discharges are thought to occur very rarely (Sandie Wilson, Portland Port, Personal Communication).

Photos (from top left): i) Bincleaves outfall, ii) Doncaster Road CSO outfall, iii) Surface water outfall at Wyke Regis, iv) Ferrybridge SPS, v) Osprey Quay surface water outfall, vi) Castletown (Victoria Square SPS) outfall



Photos (continued, from top left): vii) Castletown outfall, viii) Merchants CSO outfall, ix) Outfall at Coaling Pier Bridge, Portland Port, x) Coaling Pier, Portland Port, xi) Balaclava Bay, xii) Balaclava Bay SPS outfall

8. OVERALL ASSESSMENT

There are no significant continuous sewage discharges into Portland Harbour. Consequently levels of bacterial contamination in the harbour, as evidenced by high bathing and shellfish water quality, are generally very low.

Sewerage network modelling undertaken by Wessex Water indicates that storm and emergency discharges to the harbour spill infrequently (the predicted aggregated spill frequency is 7 spills of more than 50 m^3 per year). However, in the event of an emergency or storm sewage spill, contamination from the intermittent discharges at Ferrybridge, Sandsfoot Castle, Castle Cove or Castletown could impact on shellfisheries in the production area.

Hydrodynamic modelling indicates that sewage discharged from Castle Cove or Sandsfoot Castle outfalls in the northwest of the harbour would tend to move in an anticlockwise direction and could impact on the beds in the several order in the south west of the harbour. Sewage discharged from Ferrybridge SPS would also impact on the shellfisheries in the several order and it is recommended that the current monitoring point for scallops should be moved to be more representative of contamination from this source.

Weymouth and Portland are very popular for tourism and the local population increases markedly in the summer. Dry weather sewage flows will therefore increase during the summer. However, there is no evidence of a summer peak in levels of contamination of shellfish and it is therefore considered unnecessary to increase sampling frequency during the summer.

The sailing events for the 2012 Olympic Games will be hosted in Portland Harbour and there may be a temporary increase in pollution risk during these events due to the large number of visitors expected. The LEA should consider increasing sampling frequency during this period on a precautionary basis.

The yacht marinas and moorings within Weymouth Harbour are highly unlikely to represent a significant source of microbiological contamination of shellfisheries in the production area due to their distance from Portland Harbour. Portland Marina is within 200m of the several order boundary, and within the area that is currently classified for the production of scallops. Marinas should not be classified for shellfish production and the classification zone boundary should be revised to exclude the marina.

Plume dispersion modelling undertaken by HR Wallingford (Section 5.2) indicates that contaminants released in the vicinity of the marina could impact on shellfisheries in the several order bed. However, recent water quality monitoring undertaken by the Environment Agency (Section 6.3) provides no evidence of an increase in levels of contamination in the water column near the marina and it is considered unnecessary to extend an exclusion zone for harvesting around the marina entrance into the several order bed.

The discharge of boat toilets in or near the harbour may represent a sporadic but unpredictable source of faecal contamination of the production area, particularly in the summer months. However, as stated above, there is no evidence of a summer peak in levels of contamination of shellfish and it is considered unnecessary to increase sampling frequency during the summer.

Birds represent a sporadic but unpredictable source of faecal contamination of shellfisheries in the production area. Large numbers of gulls are present in the harbour and several species nest or roost on the breakwaters in close proximity to the mussel rope farms. In addition, large numbers of wintering wildfowl are present in the Fleet (west of the production area) and Radipole Lake (north of the production area).

Whilst faecal contamination from birds in Radipole Lake is unlikely to represent a significant source of contamination of shellfisheries in Portland harbour, faecal contamination from birds in the Fleet could impact on shellfisheries in the several order. Consideration of tidal currents in the vicinity of the several order indicates that, depending on the presence of sufficient stocks for sampling, the current monitoring point for scallops should be moved to be more representative of worst case scenario of contamination. The current location of the trial oyster cage is considered to be well placed to reflect any contamination from this source.

9. RECOMMENDATIONS

Details of the proposed monitoring locations and classification zones are provided in the Sampling Plan (Appendix 1). Specific recommendations relating to changes in the locations of monitoring points and classification zone boundaries are:

1. The classification zone encompassing the scallop bed in the several order should be revised in order to exclude Portland Marina.

2. The monitoring point for scallops in the several order should be moved in order to be more representative of worst case contamination from the Fleet (faecal contamination of birds and sewage spills from Ferrybridge SPS).

3. New monitoring points for mussels and Pacific oysters should be established on relocation of the Lyme Bay Shellfish farm to the North Eastern Breakwater.

4. Monitoring at Bincleaves Groyne should cease on relocation of the Lyme Bay Shellfish farm to the North Eastern Breakwater.

Parallel monitoring of mussels from the top and bottom of the mussel ropes at the Eastern Breakwater and of Pacific oysters in the top and bottom of the lantern nets at Bincleaves Breakwater has provided no evidence of systematic variation in levels of contamination with depth. It is recommended that samples are collected from the top of the mussel ropes and lantern nets at both sites.

Mussel samples are currently collected directly from the mussel ropes, either by diving (Eastern Breakwater) or following rope recovery by boat (Bincleaves Breakwater). Whilst it is recommended that samples are collected using the same method as harvesting, the use of sample bags should be considered if sampling method results in the exhaustion of suitably sized shellfish at the monitoring point.

There may be a temporary seasonal increase in pollution risk during the Olympic Games and the run up to them in 2010-12. The LFA should consider increasing sampling frequency during this period on a precautionary basis.

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GLOSSARY

Analysis of Variance (ANOVA)	A statistical test which compares the distribution of two or more sample groups to determine if one or more of the groups are significantly different from the others
Bathing Water	A body of water used for bathing by a significant number of people. Bathing waters may be classed as either EC designated or non-designated OR Those waters specified in Section 104 of the Water Resources Act, 1991
Bivalve mollusc	Any marine or freshwater mollusc of the class *Pelecypoda* (formerly *Bivalvia* or *Lamellibranchia)*, having a laterally compressed body, a shell consisting of two hinged valves, and gills for respiration. The group includes clams, cockles, oysters, and mussels.
Classification of shellfish harvesting areas	A system for grading harvesting areas based on levels of bacterial indicator organisms (*E. coli*)
Coliform	Gram negative, facultative anaerobic rod-shaped bacteria which ferment lactose to produce acid and gas at 37°C. Members of this group normally inhabit the intestine of warm-blooded animals but may also be found in the environment (e.g. on plant material and soil).
Combined Sewer Overflow (CSO)	A system for allowing the discharge of sewage (usually dilute crude) from a sewer system following heavy rainfall. This diverts high flows away from the sewers or treatment works further down the sewerage system.
Discharge	Flow of effluent into the environment.
Discharge Consent	An authorisation issued by the Environment Agency to control the discharge of polluting matter to surface or underground waters
Dry Weather Flow (DWF)	The average daily flow to the treatment works during seven consecutive days without rain following seven days during which rainfall did not exceed 0.25 mm on any one day (excludes public or local holidays). With a significant industrial input the dry weather flow is based on the flows during five working days if production is limited to that period.
EC Directive	Community legislation as set out in Article 189 of the Treaty of Rome. Directives are binding but set out only the results to be achieved leaving the methods of implementation to Member States, although a Directive will specify a date by which formal implementation is required.
Emergency overflow	A system for allowing the discharge of sewage (usually crude) from a sewer system or sewage treatment works in the case of equipment failure.
***Escherichia coli* (*E. coli*)**	A species of bacterium that is a member of the faecal coliform group (see below). It is more specifically associated with the intestines of warm-blooded animals and birds than other members of the faecal coliform group. The enterohemorrhagic strain of this bacterium O157:H7 is the

	cause of infection in humans, such as bloody diarrhoea and occasionally kidney failure.
Faecal coliform	Coliforms (see above) which can produce their characteristic reactions (e.g. production of acid from lactose) at 44°C as well as 37°C. Usually, but not exclusively, associated with the intestines of warm-blooded animals and birds.
Geometric mean	The geometric mean of a series of N numbers is the N^{th} root of the product of those numbers. It is more usually calculated by obtaining the mean of the logarithms of the numbers and then taking the antilog of that mean. It is often used to describe the typical values of a skewed data such as one following a log-normal distribution.
Guideline (G) values	Values set in European Directives that the Member States have to endeavour to achieve
HR Wallingford	A company with a history of modelling of river, marine and coastal processes.
Hydrodynamic model	In this context a numerical model that approximates the detail of real fluid flow i.e. velocities and water levels as functions of time and space. Output from these models can be used together with a representation of the diffusive process in the water column (Particle Transport Models) to represent the fate and dispersion of bacteria.
PLUME-RW	A Lagrangian dispersion model, that is generally used to simulate the fate of relatively small effluent plumes
POLTIPS	Tidal prediction software developed by Proudman Oceanographic Laboratory
Several Order	An order that restricts the public right to fish in a defined area of the sea or coastal waters, as regulated under the terms of the Sea Fisheries (Shellfish) Act 1967, Chapter 83. It is granted to a person or, company for named shellfish species, for a set period of time, to establish, improve and protect a shellfish fishery.
Sewage	Sewage can be defined as liquid, of whatever quality that is or has been in a sewer. It consists of waterborne waste from domestic, trade and industrial sources together with rainfall from subsoil and surface water.
Sewage Treatment Works (STW)	Facility for treating the wastewater from predominantly domestic and trade premises.
Sewerage	A system of connected sewers, often incorporating inter-stage pumping stations and overflows.
TELEMAC-2D	A hydrodynamic model (see above) used to simulate free-surface flows in two dimensions of horizontal space.
Waste water	Any waste water but see also "sewage".

LIST OF ABBREVIATIONS

2D	Two dimensional
ANOVA	Analysis of variance
BOD	Biochemical Oxygen Demand
BMPA	Bivalve Mollusc Production Area
Cefas	Centre for Environment Fisheries and Aquaculture Science
CSO	Combined Sewer Overflow
DWF	Dry Weather Flow
EA	Environment Agency
E. coli	*Escherichia coli*
EC	European Community
EO	Emergency Outfall
EU	European Union
FFT	Flow to full treatment
FSA	Food Standards Agency
HW	High Water
hr	Hour
kg/d	Kilograms per day
km	Kilometre
LAT	Lowest Astronomical Tide
LFA	Local Food Authority
LW	Low Water
m^3/d	Cubic metres per day
mg	Milligrams
ml	Millilitres
MLWN	Mean Low Water Neap
MLWS	Mean Low Water Spring
MPN	Most probable number
NGR	National Grid Reference
OS	Ordnance Survey
pe	Population equivalent
PHA	Port Health Authority
ppt	Parts per thousand
RMP	Representative Monitoring Point
RSPB	Royal Society for the Protection of Birds
spp.	Species
SPS	Sewage pumping station
STW	Sewage Treatment Works
SWD	Shellfish Waters Directive
UK	United Kingdom
WPBC	Weymouth and Portland Borough Council

EC Regulation 854/2004

CLASSIFICATION OF BIVALVE MOLLUSC PRODUCTION AREAS IN ENGLAND AND WALES

SAMPLING PLAN

Portland Harbour - Dorset

2009

APPENDIX. SAMPLING PLAN

P1 GENERAL INFORMATION

Location Reference

Production Area	Portland Harbour
Cefas Main Site Reference	M025
Cefas Area Reference	FDR 2799
Ordnance Survey 1:25,000 map *Admiralty Chart*	Explorer OL 15 Purbeck & South Dorset No 2268 Portland Harbour

Shellfishery

Species	*Culture*	*Seasonality of harvest*
Mussels (*Mytilus* spp.)	Rope	All year round
Scallops (*Pecten maximus*)	Bed culture	Predominantly in winter
Pacific oysters (*Crassostrea gigas*)	Lantern nets Trays in bed frame	All year round
Native oysters (*Ostrea edulis*)	Trays in bed frame	Al year round

Local Food Authority

Local enforcement authority	Weymouth Port Health Authority
Address	Council Offices, North Quay, Weymouth, Dorset, DT4 8TA
E-mail	envhealth@weymouth.gov.uk
Telephone	01305 838430
Sampling Officer	Nigel Emery (Senior Port Health Officer)

P2 MONITORING POINTS

See map and table below.

P3 FREQUENCY OF SAMPLING

Samples should be collected at least monthly from all RMPs.

P4 REQUIREMENT FOR REVIEW

The competent authority will review this sampling plan within six years or in light of any obvious known changes in sources of pollution of human or animal origin (e.g. following a sewerage improvement scheme).

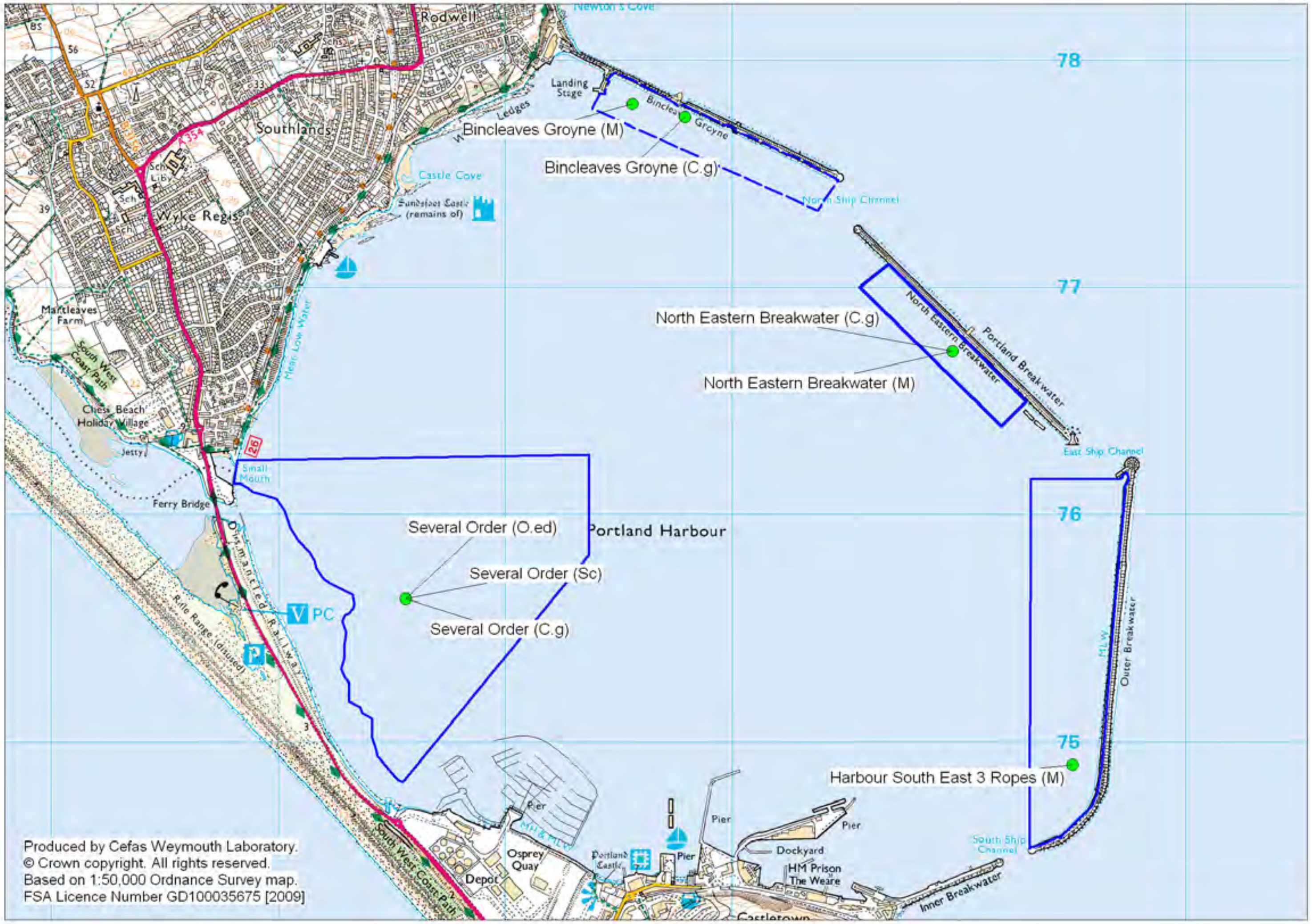

Figure P1: Recommended Representative Monitoring Points (RMPs) in Portland Harbour

Table P1: Recommended Representative Monitoring Points (RMPs) in Portland Harbour

RMP ID	RMP name	Species	National Grid Reference	Lat/Long (WGS84)		Notes
				Latitude	Longitude	
B25AB	Bincleaves Groyne (C.g)	Pacific oysters	SY 6879 7775	50° 35.920' N	02° 26.540' W	Monitoring to cease on relocation of mussel farm
B25AA	Bincleaves Groyne (M)	Mussels	SY 6856 7781	50° 35.950' N	02° 26.735' W	See above
B025J	Harbour South East 3 Ropes (M)	Mussels	SY 7050 7490	50° 34.386' N	02° 25.077' W	
B025T	Scallop Bed Several Order (Sc)	Scallops	SY 6806 7625	50° 35.106' N	02° 27.151' W	
B025?	North Eastern Breakwater (M)	Mussels	SY 6997 7672	50° 35.366' N	02° 25.535' W	Monitoring to start on relocation of mussel farm
B025?	North Eastern Breakwater (C.g)	Pacific oysters	SY 6997 7672	50° 35.366' N	02° 25.535' W	See above
B025AC	Several Order (O.ed)	Native oysters	SY 6756 7563	50° 34.770' N	02° 27.572' W	RMP location to be reviewed if further bed frames are deployed
B025?	Several Order (C.g)[1]	Pacific oysters	SY 6756 7563	50° 34.770' N	02° 27.572' W	Preliminary monitoring required if this species is also cultivated