

**A baseline survey of Widewater lagoon, West Sussex
2013**

A Report to West Sussex County Council

by

The Biogeography and Ecology Research Group

University of Brighton

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This report comprises five sections:

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1. Introduction

Widewater lagoon, at Lancing, near Shoreham, West Sussex (TQ200042) is a shallow, micro-tidal saline lagoon about 4 ha in size that lies parallel to the coastline, separated from the sea to the south by a shingle bank. The northern shore has houses upon it along the length of the lagoon. Widewater is believed to have formed naturally from the movement of coastal shingle isolating a section of the Adur estuary, and as such has been referred to as a 'true' lagoon, although this has been contended (Everett, 1993).

Widewater supports several flora and fauna considered to be specialist lagoonal species (Sheader and Sheader, 1990; Bamber *et al.*, 1992; Sussex Biodiversity Partnership, 2000; Bamber *et al.*, 2001; Joyce, 2002a; Joyce *et al.*, 2005; Joyce, 2006) and consequently has long been known as a site of conservation interest (Barnes, 1989; Sheader and Sheader, 1989; Smith and Laffoley, 1992; Downie, 1996). In particular, it is the only known locality in the world for *Edwardsia ivelli* (Ivell's sea anemone), although this was last recorded in 1983 (Sheader and Sheader, 1985) despite focussed surveys undertaken by BERG in 2001-3 (Joyce, 2003). A management plan for Widewater lagoon was prepared (Everett, 1993), but only partly implemented (Dolphin Ecological Surveys, 2000: Sussex Biodiversity Partnership, 2000). A new management plan is to be produced in 2014.

Sea water input to the lagoon is naturally by percolation and freshwater supply believed to be largely from precipitation (Sheader and Sheader, 1990; Everett, 1993). Recharge through the sea barrier has been insufficient to maintain high water levels during drought years and in hot summers when evaporation rates exceed water inputs (Everett, 1993). As part of coastal defence works in 2002-3, a pipe was constructed through the shingle barrier that allowed sea water to ingress Widewater lagoon on a controlled basis. The pipe has been operational since June 2003, since when sea water has regularly entered Widewater by this means.

1.1 Aims and objectives

The main aim of the project was to undertake a baseline survey of the flora and invertebrate fauna of the lagoon in order to allow comparison with previous surveys, notably the BERG surveys of 2001-5 (Joyce, 2002a; 2002b; 2003, 2005, 2006). A further objective was to evaluate any effects of the sea water pipe on the aquatic flora and fauna.

2. Methods

2.1 The baseline survey

The baseline survey was undertaken on 28 August 2013 following the same methods described in Joyce *et al.* (2005) in order to provide a comparison with the surveys of 2001-5. Thus, samples were taken of salinity, flora, and fauna present in the substrate, on

vegetation and in the water column/substrate interface. Samples were taken in a stratified random manner such that the all major sections of the lagoon were represented.

Salinity samples were taken at ten different locations within the lagoon using a portable refractometer. For flora, ten samples were taken at different locations within the lagoon. In shallow water, the % cover of all plant taxa (including algae) was recorded in 2m² quadrats. A grapnel was used where necessary in deeper water. Four repeat grapnel 'throws' were combined to yield the equivalent of one 2m² quadrat. Plant taxa were identified in the field where possible, otherwise samples were taken to the University of Brighton for identification. For fauna, 15 samples were taken aimed at collecting species from the substrate, flora, and water column. Fauna present on five of the floral samples were collected in the field, or vegetation was taken to the laboratory where invertebrates were removed. Five substrate samples were taken at different locations at the lagoon using a 0.05m² core in shallow water or an equivalent Van Veen grab in deeper water. A boat was used to enable access to the fauna of the substrate beneath deeper water. Substrate samples were sieved to 0.5mm mesh size and invertebrates removed from the sieves in the field. The fauna from the water column/substrate interface was sampled in five different 1m² areas using a hand net of 0.5mm mesh size or a plankton net of the same mesh size from a boat if lagoon depth was sufficient. Faunal taxa were identified and counted in the field where possible, but many invertebrates were taken to the University of Brighton laboratories for identification. Bivalves were counted separately as complete animals (shells) and individual valves. Colonial organisms, such as Bryozoa, were counted as the number of colonies. Faunal species were preserved where necessary in 70% ethanol.

Salinity measures, floral and faunal results and background information were collated in hard copy format and computerised on Excel spreadsheets (Appendix 1). Additional salinity records have been collated by West Sussex County Council since 2001; these are shown with the BERG readings (Appendix 2).

2.2 Health and safety (including risk avoidance)

The BERG team conformed to University of Brighton health and safety procedures and practice (including risk assessment) throughout the project. This included:

- Introductions to health and safety procedures
- Any issues that could affect safety made known prior to the project
- Use of University vehicles
- No lone working in the field
- Mobile phones for field workers
- Protective clothing (including life-jackets and laboratory clothing) supplied by the University (or West Sussex County Council for their employees)
- Guidance notes for field and laboratory safety issued to each team member at the beginning of the project
- Risk assessment and hazardous substance (COSHH) regulation forms completed and practices monitored for the project,

- University first-aid kits available to field workers

3. Results and Discussion

The long-term average salinity for Widewater is given by Everett (1993) as 25-30‰ in winter and 35-40‰ in summer. Prior to the opening of the sea water pipe in June 2003, BERG measurements suggest that salinity in 2001-3 was generally somewhat below these long-term figures, with values of 18-28‰ in winter and 26-33‰ in summer (Table 1). Salinity levels apparently increased soon after the opening of the pipe, indicated by measurements of 33‰ on 22 July and 42‰ on 11 September 2003. Measures in August 2004, 2005 and 2013, of 40‰, 37‰ and 43‰ respectively (Table 1), suggest a return to the long-term summer average, or perhaps a little above. Records in recent years collated by West Sussex County Council support the notion of seasonal fluctuations within the typical long-term pattern for Widewater (Appendix 2).

Table 1. Salinity measures made by BERG at Widewater 2001-13. Each value is derived from at least three (and usually 10) replicate samples from different sections of the lagoon.

Date	Salinity ‰
22 June 2001	33
7 July 2001	26
23 July 2001	26
20 August 2001	28
21 August 2002	26
19 September 2002	28
6 November 2002	28
14 January 2003	18
4 March 2003	22
19 May 2003	29
22 July 2003	33
11 September 2003	42
31 August 2004	40
24 August 2005	37
28 August 2013	43

The results of the flora and fauna survey of 2013 are summarised in Table 2 in comparison to the BERG surveys of 2001-5. Further details of past records are available in Shearer and Shearer (1990) and Everett (1993). The 2013 survey confirmed the conservation interest of Widewater lagoon, with three specialist lagoonal species recorded (as defined by Bamber *et al.*, 2001), namely *Ruppia maritima*, *Cerastoderma glaucum* and *Hydrobia ventrosa*, as well as *Enochrus bicolor*, a nationally notable water beetle confined to brackish water (Greenwood and Wood, 2003). However, the sustained recovery of *R. maritima* since it was rediscovered at the site in 1993 (Everett, 1993), with a relative abundance consistently recorded in 2001-5 (Table 2), appears to be threatened.

This plant species was rarely found in flora samples in 2013 (Table 2) and additional searches located few plants. In contrast, the filamentous algae *Chaetomorpha mediterranea* was much more abundant than in previous years (Table 2), which may have reduced *R. maritima* growth and production during the summer (Verhoeven, 1980). Numbers of the snail *H. ventrosa* collected in 2013 were the highest since 2001 but numbers of the cockle *C. glaucum* were lower than most years (Table 2).

The results continue to highlight the dynamic character of the biotic community at Widewater with the crustaceans *Gammarus locusta* and *Corophium acherusicum* both appearing for the first time, the latter in abundance (Table 2). *G. locusta* is a relatively marine species that is common in the North East Atlantic and Great Britain (Fish and Fish, 2011), found amongst algae, on sediment and under stones, and apparently outcompeting other *Gammarus* species at salinities greater than 15‰ (Barnes, 1994). *C. acherusicum* is a cosmopolitan species of intertidal and infralittoral habitats down to at least 20‰, building mud tubes on submerged vegetation and hard surfaces, for example in harbours and estuaries (Barnes, 1994). The amphipod *Microdeutopus gryllotalpa* has continued to flourish since 2005 (Table 2). This species is a common inhabitant of subtidal, shallow benthic habitats beneath or amongst vegetation, rock pools, docks, salt-marshes and lagoons in north west Europe, especially in salinities above 18‰ (Barnes, 1994). The bivalve *Abra tenuis*, and the crustaceans *Palaemonetes varians* and *Maera grossimana*, which were all previously recorded with some abundance or consistency, were not found in 2013.

Thus, the species that characterise the latest baseline survey of Widewater are generally typical of shallow marine, intertidal, estuarine, or lagoonal waters and can tolerate variable (including high) salinity (e.g. *Chaetomorpha mediterranea*, *Hydrobia ventrosa*, *Cerastoderma glaucum*, *Corophium acherusicum*, *Microdeutopus gryllotalpa*). Some cosmopolitan sub or infralittoral species have increased since 2004, and some species more typical of reduced salinity may have been lost (e.g. *Abra tenuis*), which may reflect more stable salinity and/or water levels in the lagoon due to hydrological control via the seawater pipe.

Table 2. Summary of 2001-13 survey results for Widewater. For all visits except 23 July 2001, flora is presented as mean % cover of 10 samples and fauna as total number in 15 samples comprising 5 of the substrate, 5 of the vegetation and 5 of the water column/substrate interface. Results for 23 July 2001 are given in parentheses as the survey comprised 5 fauna samples of the substrate only. [√] = shells, ^x = valves.

Taxa	22 Jun 01	7 Jul 01	(23 Jul 01)	20 Aug 01	21 Aug 02	22 Jul 03	31 Aug 04	24 Aug 05	28 Aug 13
FLORA									
<i>Ruppia maritima</i>	31	31		36	29	24	33	30	1
<i>Chaetomorpha mediterranea</i>	23	19		21	29	14	23	14	69
<i>Cladophora laetevirens</i>	1	2		20				6	5
<i>Enteromorpha intestinalis</i>	16	1		3				2	2
<i>Derbesia marina</i>	1			2					
<i>Ulva lactuca</i>				2	2	1	1	5	

<i>Rhizoclonium tortuosum</i>	9								
Baccillariophyceae				3			1		
Cyanophyta					4		1		
FAUNA									
<u>Nemertea</u>									
Nemertea indet.					1				2
<u>Cnidaria</u>									
<i>Actinia</i> sp.	2								
<i>Halecium</i> sp. (no. colonies)				1					
<u>Annelida</u>									
<i>Arenicola marina</i>	2	5		17	2	4	1	2	
<i>Lumbrineris</i> sp.	5								
Enchytraeidae indet.	3			1			1		
<i>Tubificoides benedi</i>	1					1			
<i>Tubificoides</i> sp.									12
<i>Tubifex</i> sp.				9					
<i>Hediste diversicolor</i>		14		4	49	55	16		6
<i>Perinereis cultrifera</i>		1			2	20			
<i>Perinereis</i> sp.									3
<i>Polydora</i> sp.									2
<u>Sipuncula</u>									
Golfingiidae indet.				3					
<u>Mollusca</u>									
<i>Hydrobia ventrosa</i>	2081	1416	(235)	552	342	671	110	298	1201
<i>Hydrobia neglecta</i>	8		(3)						
<i>Hydrobia ulvae</i>					4				
<i>Rissostomia</i> sp.	1			6					
<i>Cerastoderma glaucum</i>	247 ^v 568 ^x	84 ^v 162 ^x	(152 ^v 260 ^x)	194 ^v 165 ^x	23 ^v 72 ^x	216 ^v 430 ^x	115 ^v 260 ^x	60 ^v 1 ^x	24 ^v 2 ^x
<i>Abra tenuis</i>	215 ^v 72 ^x	151 ^v 49 ^x	(99 ^v 36 ^x)	202 ^v 114 ^x	17 ^v 14 ^x	36 ^v 30 ^x	15 ^v 25 ^x	24 ^v 0 ^x	
<i>Littorina rudis</i>				5		21	7		
<i>Littorina tenebrosa</i>				11					
<u>Insecta</u>									
Chironominae	43	16	(57)	23	12	59	13	699	40
Ephydriidae									5
Culicidae						3			
<i>Berosus spinosus</i>	1								
<i>Berosus</i> sp.					1				
<i>Helochaeres lividus</i>	1			1					
<i>Hydrobius</i> sp.					3				
<i>Enochrus bicolor</i>	1								21
Corixinae		1							
<u>Crustacea</u>									
<i>Lekanesphaera</i> sp.	1								
<i>Gammarus duebeni</i>		3			4	5			
<i>Gammarus locusta</i>									18
<i>Gammarus</i> sp.							1	1	
<i>Corophium acherusicum</i>									1109

<i>Corophium volutator</i>									9
<i>Maera grossimana</i>					6	9	11	6	
<i>Melita palmata</i>					4	38	3		2
<i>Schistomysis</i> sp.					1				
<i>Palaemonetes varians</i>		3		12	20	81	48	9	
<i>Apherusa jurinei</i>								4	
<i>Microdeutopus gryllotalpa</i>								308	537
Cumacea								1	
Isaeidae								1	
<u>Lysianassidae</u>						1			
<u>Bryozoa</u> (no. colonies)						2			
<i>Bowerbankia</i> sp.						2			
<i>Bowerbankia gracilis</i>								2	
<i>Conopium seurati</i>	1		(4)						
<i>Membranipora membranacea</i>			(1)						
<i>Nolella dilatata</i>							3		
<i>Cryptosula pallasiana</i>			(1)						
<i>Electra</i> sp.				1					

Note: other invertebrate taxa recorded at Widewater in 2001-4 (but not in baseline surveys) were: *Haliplanella lineata* (Cnidaria) in substrate in July-September 2002; Copepoda in water samples taken with a plankton net in July 2003; *Lineus* sp. (Nemertea) in substrate in September 2002 and September 2003. Nematoda, Ostracoda and Copepoda were recorded in baseline samples in August 2005. *Talitrus saltator* was also recorded in August 2005. Nematoda, the exuvia of *Palaemonetes varians*, and dead *Conopium seurati* were also recorded in August 2013.

4. Conclusions

The baseline survey of 2013 reaffirmed the conservation value of Widewater as a saline lagoon. The presence of the nationally notable water beetle *Enochrus bicolor* is also of conservation interest. Surveys indicate that salinity levels in the lagoon have been elevated by sea water ingress since June 2003 through the pipe associated with adjacent coastal defences, such that summer levels are apparently consistent with (or a little above) the longer-term average. A comparison of surveys during 2001-13 indicates the dynamic nature of the lagoonal flora and fauna. After years of stable abundance, the much reduced population of the indicator plant *Ruppia maritima* in 2013 is potentially detrimental to the lagoon's conservation status. There is no overwhelming evidence of biotic change induced by sea water input from the pipe, but it is possible that generalist, cosmopolitan, marine animal species suited to higher salinities including some crustaceans have increased, thereby reducing the distinctiveness of the lagoonal community at Widewater. Such trends highlight the value of continued sampling and monitoring of the lagoon.

Management of the lagoon should therefore focus upon maintaining a micro-tidal hydrological regime that maintains salinity at levels similar to the long-term pattern (i.e.

25-30‰ in winter and 35-40‰ in summer). Short-term variability in salinity is a characteristic of lagoons generally (Bamber *et al.* 2001) but excessive salinity may be detrimental to specialist lagoon biota at Widewater so it is recommended that prolonged exposure to salinity above 40‰ is avoided. It is also recommended that the abundance of the specialist plant species *Ruppia maritima* is monitored in relation to other flora to establish whether the substantial reduction recorded this year is a short-term phenomenon or persistent, and to begin to elucidate possible reasons for any changes.

4.1 Further study

It is generally recommended that more intensive surveys and monitoring are initiated in order to attempt to resolve long-standing uncertainties over the dynamics, functioning and conservation value of Widewater lagoon and other lagoons in Sussex. This should include temporal and spatial investigations of salinity, hydrology, and populations of flora and fauna. Further studies at Widewater would therefore provide a useful basis for a better understanding of the ecological functioning and dynamics of saline lagoons, and the interactions between 'natural' processes (e.g. climate change) and human intervention (e.g. flood defence, lagoon management).

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Appendix 1 Baseline survey data 2001-13

Site name	Grid reference		Date surveyed																					
Widewater a*	TO200042		22 06 01																					
Surveyor(s)	Water area (ha)		Status (e.g. SSSI)																					
SM CH G	3.7EN4.73GIS		SNCI																					
Substrate (% of clay, mud/silt, sand, shingle/gravel, boulders, hard, e.g. concrete)																								
30% clay, mud/silt 65%, shingle 5%																								
Freshwater inflow (e.g. type of channel, precipitation only)																								
Precipitation																								
Saltwater inflow (e.g. natural channel, artificial channel, overtopping, percolation)																								
percolation																								
Management/use (e.g. dog walkers, birdwatchers, vegetation clearance)																								
dogwalkers																								
Associated wildlife (e.g. amphibians (esp. Frogs), birds, fish)																								
Mute swan, three-spined stickleback																								
Notes (e.g. site description)																								
Ruppia only found east of the bridge that crosses the lagoon																								
Water (W)	W1	W2	W3	W4	W5	W6	W7	W8x	W9x	W10x	WMean	WSE												
Depth (cm)	20	19	16	10	15	14	14				15.42857	1.269742												
pH	8.55	8.55	8.75	8.9	9	8.35	8.15				8.607143	0.113614												
Temp (OC)	19.8	17.6	19	18.8	18.4	20.4	21				19.28571	0.446909												
Salinity (ppt)	34.02	34.92	33.13	34.5	34.02	30.04	30.9				33.07571	0.709889												
Flora (FL) (% cover/DAFOR)	FL1	FL2	FL3	FL4	FL5	FL6	FL7	FL8	FL9	FL10	FLMean	FLSE												
Total	A	D	D	None	R	D	A	D	D	R														
<i>Derbesia marina</i>									R	R														
<i>Chaetomorpha mediterranea</i>	O	D	O		R	R	R	O	D	R														
<i>Ruppia maritima</i>	O	R	D		A	F	D																	
<i>Rhizoclonium tortuosum</i>	A																							
<i>Enteromorpha intestinalis</i>					R	D	A																	
<i>Cladophora laeteviridis</i>							R																	
Fauna (number)	On flora (FF)						Substrate (FS)					Water column (FW)					Total							
	FF1	FF2	FF3	FF4	FF5	FFMean	FFSE	FS1	FS2	FS3	FS4	FS5	FSMean	FSSE	FW1	FW2	FW3	FW4	FW5	FWMea	FWSE	TotalNu	TotalMe	TotalSE
Cnidaria																								
Anthozoa																								
<i>Actinia</i> sp.	0	0	0	0	0	0	0	0	0	2	0	0	0.4	0.4	0	0	0	0	0	0	0	2	0.1333	0.1333
Annelida																								
Polychaeta																								
<i>Arenicola marina</i>	0	0	0	0	0	0	0	0	0	1	0	1	0.4	0.244949	0	0	0	0	0	0	0	2	0.1333	0.0909
<i>Lumbrinereis</i> sp.	0	0	0	0	0	0	0	3	1	0	1	0	1	0.547723	0	0	0	0	0	0	0	5	0.3333	0.2108
Oligochaeta																								
<i>Enchytraeidae</i> indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.6	0.6	3	0.2	0.2
<i>Tubificoides</i> sp.	0	0	0	0	0	0	0	0	0	0	1	0	0.2	0.2	0	0	0	0	0	0	0	1	0.0667	0.0667
Mollusca																								
Gastropoda																								
<i>Hydrobia ventrosa</i>	17	39	13	500	0	113.8	96.75402	622	100	50	100	100	194.4	107.3376	268	0	57	72	143	108	46.04	2081	138.73	47.976
<i>Hydrobia neglecta</i>	0	2	1	5	0	1.6	0.927362	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0.5333	0.3501
<i>Rissoicostoma</i> sp.	0	1	0	0	0	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0667	0.0667
Bivalvia																								
<i>Cerastoderma glaucum</i> (shells)	3	3	1	2	16	5	2.774887	57	7	76	26	16	36.4	13.00231	17	6	14	2	1	8	3.209	247	16.467	5.6668
<i>Cerastoderma glaucum</i> (valves)	9	6	2	0	0	3.4	1.777639	114	45	135	48	50	78.4	19.12747	27	70	48	14	0	31.8	12.4	568	37.867	10.865
<i>Abra tenuis</i> (shells)	1	17	7	7	0	6.4	3.026549	10	4	12	115	0	28.2	21.80459	17	0	21	0	4	8.4	4.434	215	14.333	7.4121
<i>Abra tenuis</i> (valves)	1	1	0	0	0	0.4	0.244949	0	30	0	34	0	12.8	7.863841	3	0	3	0	0	1.2	0.735	72	4.8	2.8705
Insecta																								
Diptera:																								
<i>Chironominae</i> indet.	2	1	2	0	4	1.8	0.663325	0	5	0	0	8	2.6	1.661325	2	0	1	18	0	4.2	3.47	43	2.8667	1.2339
Coleoptera:																								
<i>Berosus spinosus</i>	0	1	0	0	0	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0667	0.0667
<i>Helochares lividus</i>	1	0	0	0	0	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0667	0.0667
<i>Enochrus bicolor</i>	0	0	0	0	1	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0667	0.0667
Crustacea																								
Malacostraca																								
Isopoda:																								
<i>Lekanesphaera</i> sp.	0	0	0	0	0	0	0	0	0	1	0	0	0.2	0.2	0	0	0	0	0	0	0	1	0.0667	0.0667
Bryozoa (no. colonies)																								
<i>Conopeum seurati</i>	0	0	0	0	0	0	0	0	1	0	0	0	0.2	0.2	0	0	0	0	0	0	0	1	0.0667	0.0667

Site name	Grid reference										Date suneyed														
Widewater b'	T0200042										07 07 01														
Surveyor(s)	Water area (ha)										Status (e.g. SSSI)														
CJ CH ST	3.7EN4.73GIS										SNCI														
Substrate (% of clay, mud/silt, sand, shingle/gravel, boulders, hard, e.g. concrete)																									
Freshwater inflow (e.g. type of channel, precipitation only)																									
heavy precipitation 2 days previously																									
Saltwater inflow (e.g. natural channel, artificial channel, overtopping, percolation)																									
Management/use (e.g. dog walkers, birdwatchers, vegetation clearance)																									
Associated wildlife (e.g. amphibians (esp. Frogs), birds, fish)																									
Eels present																									
Notes (e.g. site description)																									
Vegetation much less to west of bridge (FL 6+7); mostly a little algae and little <i>Ruppia</i>																									
Lots of recently dead <i>Hydrobia</i> , fish and <i>Arenicola marina</i>																									
Anoxic black sediment to surface locally																									
Water (W)																									
	W1	W2	W3	W4	W5	W6	W7x	W8x	W9x	W10x	WMean	WSE													
Depth (cm)	7	27	8	12	8	12					12.33333	3.062316													
pH	8.55	8.55	8.7	8.75	8.75	8.7					8.666667	0.038006													
Temp (OC)	18.8	19.4	18.4	18.4	18.4	18.4					18.63333	0.166667													
Salinity (ppt)	27.11	28.21	28.1	24.97	23.93	23.5					25.97	0.858615													
Flora (FL) (% cover/DAFOR)																									
	FL1	FL2	FL3	FL4	FL5	FL6	FL7	FL8	FL9	FL10	FLMean	FLSE													
Total	60 A	27 A	8 A	95	70 R	15	60 O	90																	
<i>Ruppia maritima</i>	45 F	F		10	70 R		0	60 O		60															
<i>Chaetomorpha mediterranea</i>	15 F	O		85	0 R		0	0		30															
<i>Enteromorpha intestinalis</i>	0			0	10		0	0		0															
<i>Cladophora laetevirens</i>	0			0	0		15	0		0															
Fauna (number)																									
	On flora (FF)					Substrate (FS)					Water column (FW)					Total									
	FF1	FF2	FF3	FF4	FF5	FFMean	FFSE	FS1	FS2	FS3	FS4	FS5	FSMean	FSSE	FW1	FW2	FW3	FW4	FW5	FWMean	FWSE	TotalNumt	TotalMean	TotalSE	
Annelida																									
<i>Arenicola marina</i>																									
	0	0	0	1	0	0.2	0.2	0	0	0	0	1	1	0.4	0.244949	0	0	0	1	1	0.4	0.244949	5	0.333333	0.125988
<i>Hediste diversicolor</i>																									
	0	0	0	0	0	0	0	0	0	1	10	0	2.2	1.959592	2	1	0	0	0	0.6	0.4	14	0.933333	0.665237	
<i>Perinereis cultrifera</i>																									
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0.2	0.2	1	0.066667	0.066667	
Mollusca																									
<i>Gastropoda</i>																									
<i>Hydrobia ventrosa</i>																									
	0	5	3	0	22	6	4.110961	10	100	10	100	20	48	21.30728	1010	46	68	12	10	229.2	195.502	1416	94.4	65.99176	
Bivalvia																									
<i>Cerastoderma glaucum</i> (shells)																									
	2	1	0	0	0	0.6	0.4	10	25	10	0	30	15	5.477226	3	0	1	1	1	1.2	0.489898	84	5.6	2.460739	
<i>Cerastoderma glaucum</i> (valves)																									
	0	0	0	0	0	0	0	10	60	10	3	78	32.2	15.34405	1	0	0	0	0	0.2	0.2	162	10.8	6.227588	
<i>Abra tenuis</i> (shells)																									
	0	0	1	0	0	0.2	0.2	10	100	10	1	11	26.4	18.48946	7	0	2	5	4	3.6	1.208305	151	10.066667	6.508944	
<i>Abra tenuis</i> (valves)																									
	0	0	2	0	0	0.4	0.4	10	20	10	0	5	9	3.316625	2	0	0	0	0	0.4	0.4	49	3.266667	1.500688	
Insecta																									
Diptera:																									
Chironominae indet.																									
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	1	7	0	3.2	1.772005	16	1.066667	0.679402	
Hemiptera:																									
Corixinae indet.																									
	0	1	0	0	0	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.066667	0.066667	
Crustacea																									
Malacostraca																									
Amphipoda:																									
<i>Gammarus duebeni</i>																									
	0	0	0	0	0	0	0	0	0	0	1	0	0.2	0.2	0	0	1	1	0	0.4	0.244949	3	0.2	0.106904	
Decapoda:																									
<i>Palaeomonetes varians</i>																									
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0.6	0.244949	3	0.2	0.106904	

Site name											Grid reference			Date surveyed											
Widewater baseline 02											TO200042			21.8.02											
Surveyor(s)											Water area (ha)			Status (e.g. SSSI)											
C.J. GL RC ST											3.7EN4.73GIS			SNC											
Substrate (% of clay, mud/silt, sand, shingle/gravel, boulders, hard, e.g. concrete)																									
Freshwater inflow (e.g. type of channel, precipitation only)																									
Precipitation																									
Saltwater inflow (e.g. natural channel, artificial channel, overtopping, percolation)																									
percolation																									
Management/use (e.g. dog walkers, birdwatchers, vegetation clearance)																									
dogwalkers, some weed removal																									
Associated wildlife (e.g. amphibians (esp. Frogs), birds, fish)																									
Mute swan (incl. 2 cygnets), Dunlin (7), Common Sandpiper																									
Notes (e.g. site description)																									
Ruppia mostly found east of the bridge that crosses the lagoon, with just occasional clumps west of the bridge																									
Water (W)	W1	W2	W3	W4	W5	W6x	W7x	W8x	W9x	W10x	WMean	WSE													
Depth (cm)																									
pH																									
Temp (OC)																									
Salinity (ppt)	25.6	25.6	26.1	26	26.1						25.88	0.12													
Flora (FL) (% cover/DAFOR)	FL1	FL2	FL3	FL4	FL5	FL6	FL7	FL8	FL9	FL10	FLMean	FLSE													
Total	90	90	95	95	80	90	10	25	15	30	62	11.62													
<i>Ulva lactuca</i>	0	0	0	0	0	0	0	0	0	10	5	1.5	1.07												
<i>Chaetomorpha mediterranea</i>	65	20	90	90	20	0	0	0	0	0	28.5	12.07													
<i>Ruppia maritima</i>	25	70	5	5	60	85	0	20	0	15	28.5	9.95													
indet. Cyanophyta	0	0	0	0	0	5	10	5	5	10	3.5	1.30													
Fauna (number)	On flora (FF)						Substrate (FS)						Water column (FW)					Total							
	FF1	FF2	FF3	FF4	FF5	FFMean	FFSE	FS1	FS2	FS3	FS4	FS5	FSMean	FSSE	FW1	FW2	FW3	FW4	FW5	FWMea	FWSE	TotalNu	TotalMe	TotalSE	
Nemertea																									
Nemertea indet.	0	0	0	0	0	0	0.00	1	0	0	0	0	0.2	0.20	0	0	0	0	0	0	0.00	1	0.07	0.07	
Annelida																									
Polychaeta																									
<i>Arenicola marina</i>	0	0	0	0	0	0	0.00	0	0	2	0	0	0.4	0.40	0	0	0	0	0	0	0.00	2	0.13	0.13	
<i>Hedisto diversicolor</i>	0	0	2	2	3	1.4	0.60	0	0	11	8	32	8.2	6.14	0	0	0	1	0	0	0.2	0.20	49	3.27	2.12
<i>Perinereis cultrifera</i>	0	0	0	0	1	0.2	0.20	0	0	1	0	0	0.2	0.20	0	0	0	0	0	0	0.00	2	0.13	0.09	
Mollusca																									
Gastropoda																									
<i>Hydrobia ventrosa</i>	13	2	0	0	11	5.2	2.82	0	5	7	100	111	44.6	24.95	6	87	0	0	0	0	18.6	17.14	342	22.80	10.35
<i>Hydrobia ulvae</i>	0	0	0	0	0	0	0.00	0	4	0	0	0	0.8	0.80	0	0	0	0	0	0	0.00	4	0.27	0.27	
Bivalvia																									
<i>Cerastoderma glaucum</i> (shells)	0	0	0	0	0	0	0.00	2	3	1	1	12	3.8	2.08	0	2	0	0	2	0	0.8	0.49	23	1.53	0.79
<i>Cerastoderma glaucum</i> (valves)	0	0	0	1	0	0.2	0.20	0	2	0	7	54	12.6	10.43	0	1	0	0	7	1.6	1.36	72	4.80	3.57	
<i>Abra tenuis</i> (shells)	0	0	0	0	0	0	0.00	2	0	1	0	12	3	2.28	0	2	0	0	0	0	0.4	0.40	17	1.13	0.80
<i>Abra tenuis</i> (valves)	0	0	0	0	0	0	0.00	1	0	0	0	13	2.8	2.56	0	0	0	0	0	0	0.00	14	0.93	0.86	
Insecta																									
Coleoptera:																									
<i>Berosus</i> sp. (larvae)	0	1	0	0	0	0.2	0.20	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	1	0.07	0.07	
<i>Hydrobius</i> sp. (larvae)	0	3	0	0	0	0.6	0.60	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	3	0.20	0.20	
Diptera:																									
Chironominae indet.	0	3	0	2	0	1	0.63	0	1	0	0	0	0.2	0.20	5	1	0	0	0	0	1.2	0.97	12	0.80	0.38
Crustacea																									
Malacostraca																									
Decapoda:																									
<i>Palaeomonetes varians</i>	0	0	0	0	0	0	0.00	0	0	0	0	1	0.2	0.20	0	0	9	6	4	3.8	1.74	20	1.33	0.71	
Amphipoda:																									
<i>Gammarus duebeni</i>	4	0	0	0	0	0.8	0.80	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	4	0.27	0.27	
<i>Maera grossimana</i>	0	0	1	5	0	1.2	0.97	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	6	0.40	0.34	
<i>Melita palmata</i>	0	0	4	0	0	0.8	0.80	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	4	0.27	0.27	
Mysidacea:																									
<i>Schistomysis</i> sp.	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	0	0	1	0	0	0.2	0.20	1	0.07	0.07	

Site name											Grid reference			Date surveyed										
Widewater baseline 05											TO200042			24.08.05										
Surveyor(s)											Water area (ha)			Status (e.g. SSSI)										
Chris Joyce, Cristina Vina, Harbon, WSCC and Earthwatch training teams											3.7EN/4.73GIS			SNCI										
Substrate (% of clay, mud/silt, sand, shingle/gravel, boulders, hard, e.g. concrete)																								
Shingle, silt																								
Freshwater inflow (e.g. type of channel, precipitation only)																								
Precipitation, run-off																								
Saltwater inflow (e.g. natural channel, artificial channel, overtopping, percolation)																								
Artificial pipe, percolation																								
Management/uses (e.g. dog walkers, birdwatchers, vegetation clearance)																								
Sea water regulation via pipe, dogwalkers, birdwatchers																								
Associated wildlife (e.g. amphibians (esp. Frogs), birds, fish)																								
Mute swan, Mallard, 3 spined stickleback, goby sp.																								
Notes (e.g. site description)																								
Water (W)	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	WMean	WSE												
Depth (cm)																								
pH	8.37	8.61	8.65	8.68	8.42	8.31	8.2	8.15	8.19	8.18	8.376	0.07												
Temp (OC)	17.7	17.9	17.9	17.9	18	17.8	17.6	17.6	17.7	17.6	17.77	0.05												
Salinity (ppt)	35	35	37	38	38	38	37	37	38	38	37.1	0.38												
Flora (FL) (% cover/DAFOR)	FL1	FL2	FL3	FL4	FL5	FL6	FL7	FL8	FL9	FL10	FLMean	FLSE												
Total	15	85	20	100	90	100	75	30	5	15	53.5	12.52												
<i>Ulva lactuca</i>	0	0	0	0	0	2	45	2	0	0	4.9	4.46												
<i>Chaetomorpha mediterranea</i>	10	70	10	0	2	45	0	0	0	0	13.7	7.64												
<i>Ruppia maritima</i>	5	15	10	90	90	70	15	2	2	0	29.9	11.90												
<i>Cladophora laetevirens</i>	0	0	0	15	0	0	15	2	15	0	6.2	2.40												
<i>Enteromorpha intestinalis</i>	0	0	0	0	0	0	15	0	0	0	1.5	1.50												
Fauna (number)	On flora (FF)					Substrate (FS)					Water column (FW)					Total								
	FF1	FF2	FF3	FF4	FF5	FFMean	FFSE	FS1	FS2	FS3	FS4	FS5	FSMean	FSSE	FW1	FW2	FW3	FW4	FW5	FWMean	FWSE	TotalNum	TotalMean	TotalSE
Annelida																								
Polychaeta																								
<i>Arenicola marina</i>	0	0	0	0	0	0	0.00	0	1	0	0	1	0.4	0.24	0	0	0	0	0	0	0.00	2	0.13	0.09
Mollusca																								
Gastropoda																								
<i>Hydrobia ventrosa</i>	12	25	15	1	0	10.6	4.65	126	10	7	0	6	29.8	24.10	33	1	0	0	62	19.2	12.43	298	19.87	8.75
Bivalvia																								
<i>Cerastoderma glaucum</i> (shells)	0	0	1	0	0	0.2	0.20	10	14	12	5	18	11.8	2.15	0	0	0	0	0	0	0.00	60	4.00	1.62
<i>Cerastoderma glaucum</i> (valves)	0	0	0	1	0	0.2	0.20	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	1	0.07	0.07
<i>Abra tenuis</i> (shells)	0	2	0	0	0	0.4	0.40	16	2	2	0	2	4.4	2.93	0	0	0	0	0	0	0.00	24	1.60	1.05
<i>Abra tenuis</i> (valves)	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	0	0.00	0.00
Insecta																								
Diptera																								
Chironominae indet.	59	246	85	12	16	83.6	42.82	70	111	52	16	28	55.4	16.76	4	0	0	0	0	0.8	0.80	699	46.60	16.91
Crustacea																								
Malacostraca																								
Decapoda:																								
<i>Palaemonetes varians</i>	0	0	0	0	0	0	0.00	0	0	0	0	7	1.4	1.40	0	0	0	0	2	0.4	0.40	9	0.60	0.48
Isopoda:																								
Amphipoda:																								
<i>Gammarus</i> sp.	0	0	0	0	0	0	0.00	0	0	0	0	1	0.2	0.20	0	0	0	0	0	0	0.00	1	0.07	0.07
<i>Mesera grossimana</i>	0	1	0	0	5	1.2	0.97	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	6	0.40	0.34
Cumacea																								
Isaeidae indet.	1	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	1	0	0	0	0	0.2	0.20	1	0.07	0.07
<i>Apherusa juninei</i>	0	0	0	4	0	0	0.00	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0.00	4	0.27	0.27
<i>Microdeutopus gryllotalpa</i>	127	6	22	128	3	0	0.00	18	0	0	0	0	0	0.00	4	0	0	0	0	0.8	0.80	308	20.53	11.35
Bryozoa (no. colonies)																								
<i>Bowerbankia gracilis</i>	0	0	0	0	0	0	0.00	0	2	0	0	0	0.4	0.40	0	0	0	0	0	0	0.00	2	0.13	0.13

**Appendix 2 Salinity records 2001-13 collected by BERG and West
Sussex County Council (in italics)**

Date	Salinity ‰
22 June 2001	33
7 July 2001	26
23 July 2001	26
20 August 2001	28
21 August 2002	26
19 September 2002	28
6 November 2002	28
14 January 2003	18
4 March 2003	22
19 May 2003	29
22 July 2003	33
11 September 2003	42
31 August 2004	40
24 August 2005	37
<i>January 2008</i>	28
<i>February 2008</i>	28
<i>March 2008</i>	27
<i>April 2008</i>	31
<i>June 2008</i>	36
<i>December 2008</i>	31
<i>February 2009</i>	29
<i>March 2009</i>	28
<i>July 2009</i>	40
<i>August 2009</i>	38
<i>December 2009</i>	25
<i>March 2010</i>	27
<i>May 2010</i>	30
<i>June 2010</i>	35
<i>February 2011</i>	27
<i>April 2011</i>	31
<i>May 2011</i>	35
<i>February 2012</i>	32
<i>April 2012</i>	35
<i>11 May 2012</i>	31
<i>26 June 2012</i>	31
<i>13 September 2012</i>	35
<i>29 November 2012</i>	25
<i>20 December 2012</i>	23
<i>31 January 2013</i>	23
<i>8 February 2013</i>	23
<i>19 April 2013</i>	28
<i>28 May 2013</i>	33
<i>13 June 2013</i>	35
<i>28 August 2013</i>	43