RESEARCH REPORT

2014

Study of the Wash Embayment Environment and Productivity (SWEEP)

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SWEEP

CONTENTS

Introduction

The Study of the Wash Embayment, Environment and Productivity (SWEEP) began in 2009 in response to observed declines in biomass of the Wash's cockle stocks. The Wash cockle fishery is important to the local economy and any threat to the fishery would have strong local economic and social implications. Although yearly variation in cockle stock biomass is normal, with various environmental factors and processes such as "ridging out" occurring, the 2008/2009 declines were deemed atypical with 5,000 tonnes of cockles lost from the Wrangle bed alone in 2008 (Jessop et al. 2009). In addition to the decline in cockle stocks, around the same time the growth and condition of mussels in the Wash were observed to have been relatively low over the previous years. Due to a lack of appropriate historic data, no conclusions could be drawn as to exactly what factors were driving the variation in bivalve biomass and condition in the Wash, and thus SWEEP was established to provide a baseline of water quality and productivity data, and long-term monitoring of the condition and productivity of the Wash, with the intention of providing a means to draw such conclusions.

Since the project's inception in 2009, its focus has shifted somewhat from what was initially an ambitious attempt to profile the Wash as a system by means of constructing food webs and establishing carrying capacity through a collaborative PhD project. PhD funding could not be sourced and so the aims of the project were focused in on food depletion by the shellfish lays present in the Wash. This was investigated using two water quality sondes (one mobile and one in-situ) to test chlorophyll levels in and around shellfish lays. Following completion of food depletion studies the project became a long-term monitoring tool observing patterns of water quality parameters around the Wash. For a full account of the SWEEP project's history and results refer to previous Eastern IFCA annual research reports.

2014 saw some minor changes to the project with additional monitoring sites being added, and an increased focus on mussel meat yields for the purpose of informing lay management. In addition, sonde samples were taken at shellfish sampling sites alongside other work and were included in this year's results. Troubles were encountered with the buoy sonde (see discussion) during the year and as such the 2014 in-situ monitoring data has severe limitations.

Materials and methods

Temperature, salinity, turbidity and chlorophyll were measured at various sites around the wash using two sondes. An in-situ sonde (YSI 6600 V2) was deployed on a buoy in open water to the north of Roaring Middle sand and set to log a sample every 10 minutes continuously throughout its deployment period. This was then removed monthly, or as close to monthly as possible, such that data could be downloaded and the unit serviced.

A spot sonde was deployed monthly at various sites around the Wash in order to provide a spatial representation of the parameters measured. A summary of monitoring sites can be seen in table 1 and figure 1. Seven main sites were monitored, and in addition the spot-sonde was deployed at EHO shellfish sampling sites whenever possible alongside other work in order to increase the range of data.

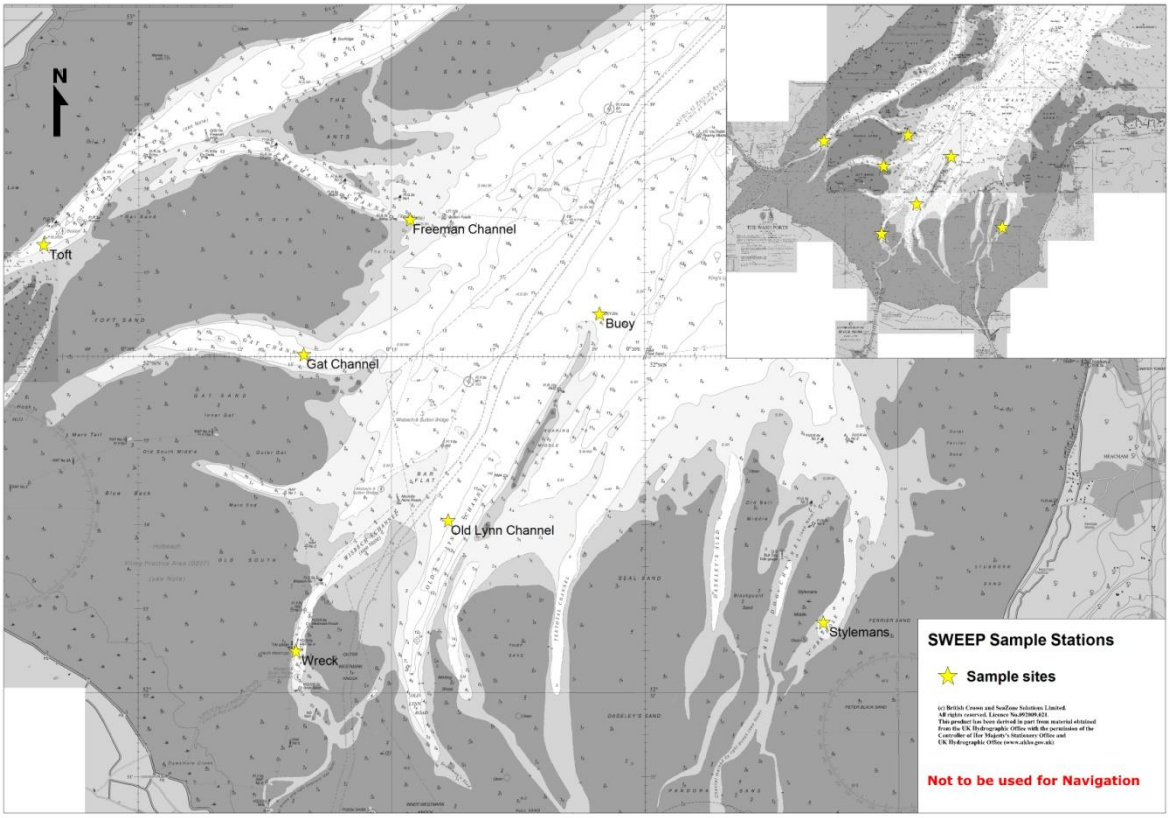


Figure 1. Primary SWEEP sampling stations in the Wash.

Data from both sondes were downloaded into EcoWatch software, before being processed in Excel. Data was then presented graphically by site to explore any patterns in the parameters monitored.

In addition to the sonde-based monitoring, samples of mussels were taken and processed to provide measures of percentage meat yields as a proxy for mussel condition, and thus indirectly, shellfish water quality. Samples were taken at four sites (table 1), but this was later reduced to the three sites of highest priority following a period of inconsistency of success in obtaining all samples. Approximately a kilogram of 45-50mm mussels were collected at each site, cleaned of barnacles and debris and then steamed in 1cm of water until all shells were open. Meats were then removed and weighed, and this weight was compared to the weight of the fresh sample to obtain a percentage meat yield.

Table 1. Summary and locations of sites included in this report, including main SWEEP sites and ancillary data from other sites in the Wash.

Station	Latitude	Longitude	Type	Notes
Black Buoy	52°56.197	000°06.172	EHO	Introduced Jul 14
Buoy	52°56.509	000°19.104	SWEEP	
Breast	52°49.917	000°15.552	EHO	Discontinued Jul 14
Freeman Channel	52°57.636	000°15.360	SWEEP	Introduced Jul 14
Gat	52°55.361	000°11.396	Meat Yield	Discontinued Sep 14
Gat Channel	52°56.028	000°13.260	SWEEP	Introduced Jul 14
Heacham South	52°53.977	000°24.168	EHO	Discontinued Jul 14
Mare Tail	52°54.730	000°08.800	EHO	Discontinued Jul 14
Nene Mouth	52°49.720	000°13.540	EHO	Introduced Jul 14
North Lays	52°57.157	000°06.720	EHO	Discontinued Jul 14
North Lays	52°57.482	000°07.225	EHO	Introduced Jul 14
Old Lynn Channel	52°54.050	000°16.110	SWEEP	Introduced Jul 14
Ouse Mouth	52°49.580	000°20.860	EHO	Introduced Jul 14
Stubborn Sand	52°54.290	000°27.970	EHO	Introduced Jul 14
Stylemans	52°52.833	000°23.512	SWEEP	
Thief	52°51.700	000°17.700	Meat Yield	
Toft	52°57.331	000°08.115	SWEEP/Meat Yield/EHO	
Training Wall	52°49.081	000°21.132	EHO	Discontinued Jul 14
Welland Wall	52°55.920	000°04.800	EHO	
Wrangle	53°00.884	000°11.884	EHO	Discontinued Jul 14
Wreck	52°52.500	000°13.100	SWEEP/Meat Yield	

Results

In-situ sonde

Problems were encountered with the in-situ sonde during 2014, leading to an incomplete data set (fig. 2). The sonde inexplicably stopped taking readings on 17 February, and due to its unattended nature this was not realised or addressed until the next collection for data download and calibration. Nothing was visually wrong with the unit and the batteries still held sufficient charge, so no explanation can be offered regarding this data gap. Readings continued as normal following service, until salinity readings shot up from

the low thirties to the low sixties (ppt) between 22 and 24 June. It is unclear why this occurred, though it may have been due to either fouling or malfunction. Finally, on 15 September during SWEEP sampling, the sonde buoy could not be located at Roaring Middle, and later turned up washed up on Hunstanton beach. Both the buoy and the sonde suffered damage resulting in a lack of data for the remainder of the year. The sonde was sent for repair and several faults were found, which may explain the earlier jump in salinity readings.

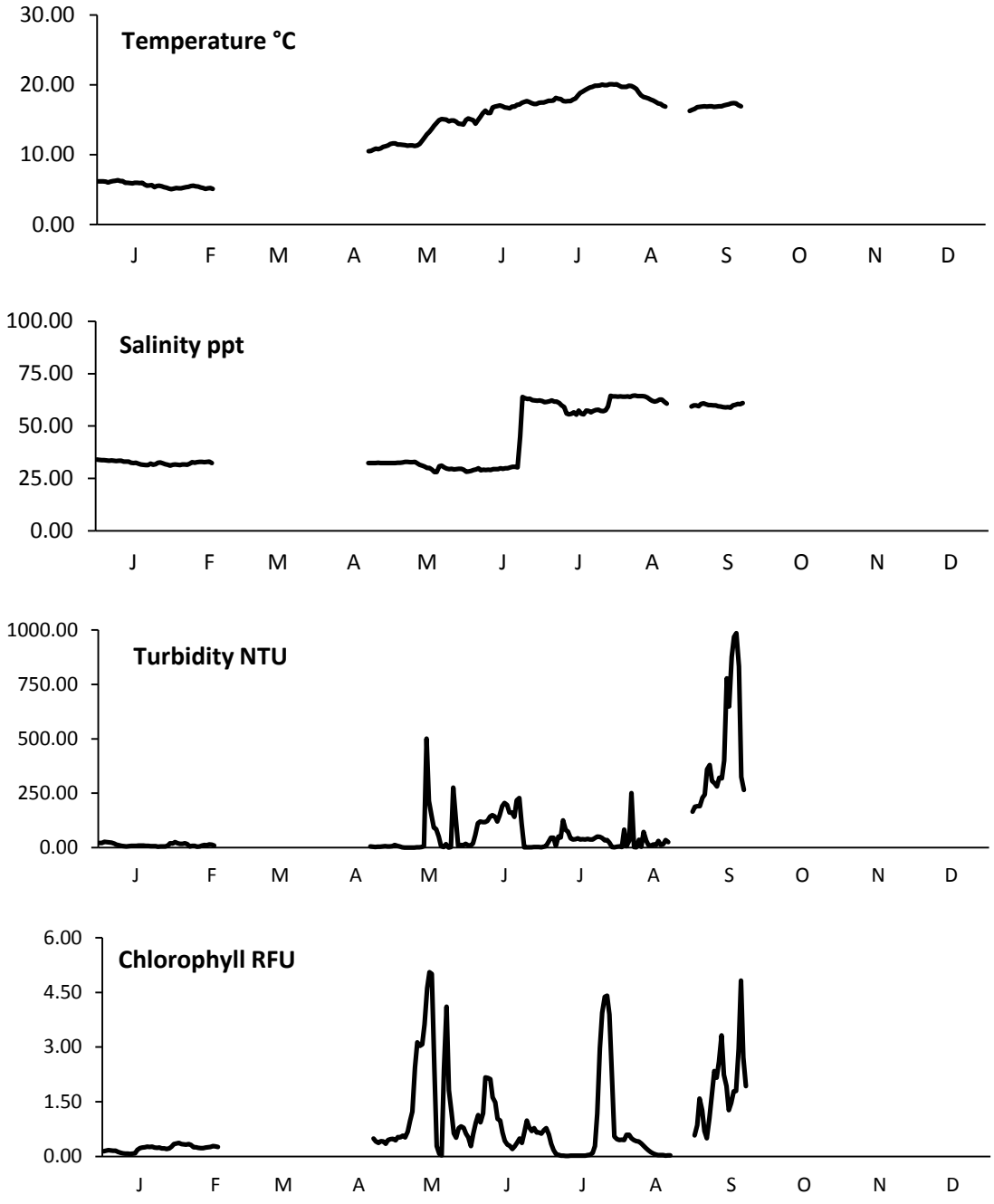
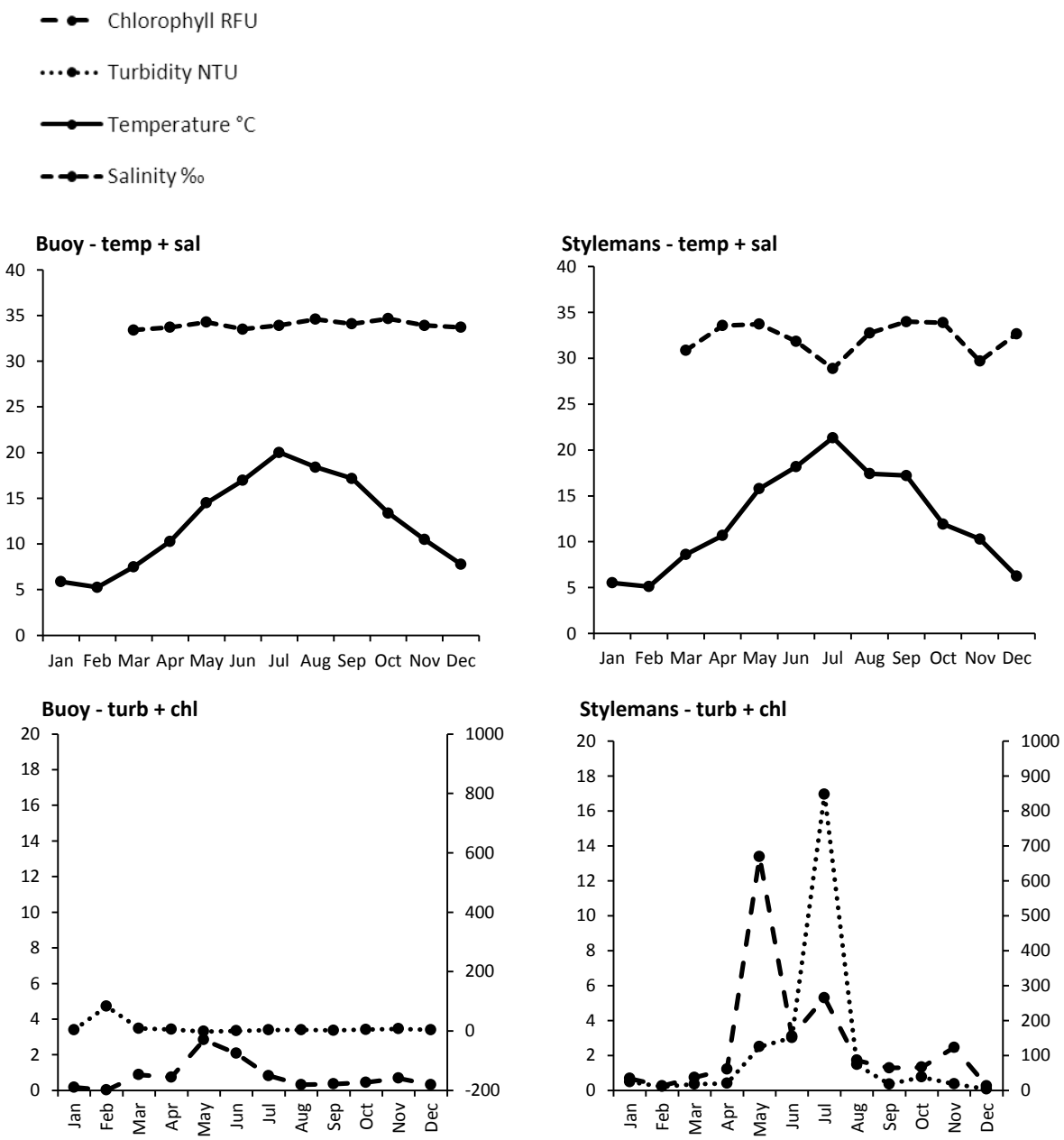


Figure 2. Buoy sonde readings for the year 2014.

Spot sonde

Spot sonde results can be seen in figure 3. Results are included from all SWEEP sites and in addition, results from EHO shellfish monitoring sites were also included. Due to a change in EHO sites in July and the addition of new SWEEP sites also in July, the figures are, for clarity of interpretation, divided into those which cover the first half of the year, those which cover the second half of the year, and those which span the entire year. It should also be noted that while the North Lays site continued to exist after July, it was moved to a nearby location and thus could be interpreted as an entirely different site. Graphs for North Lays have had a marker line applied to indicate the move. A summary of spot sonde data can be seen in table 2.



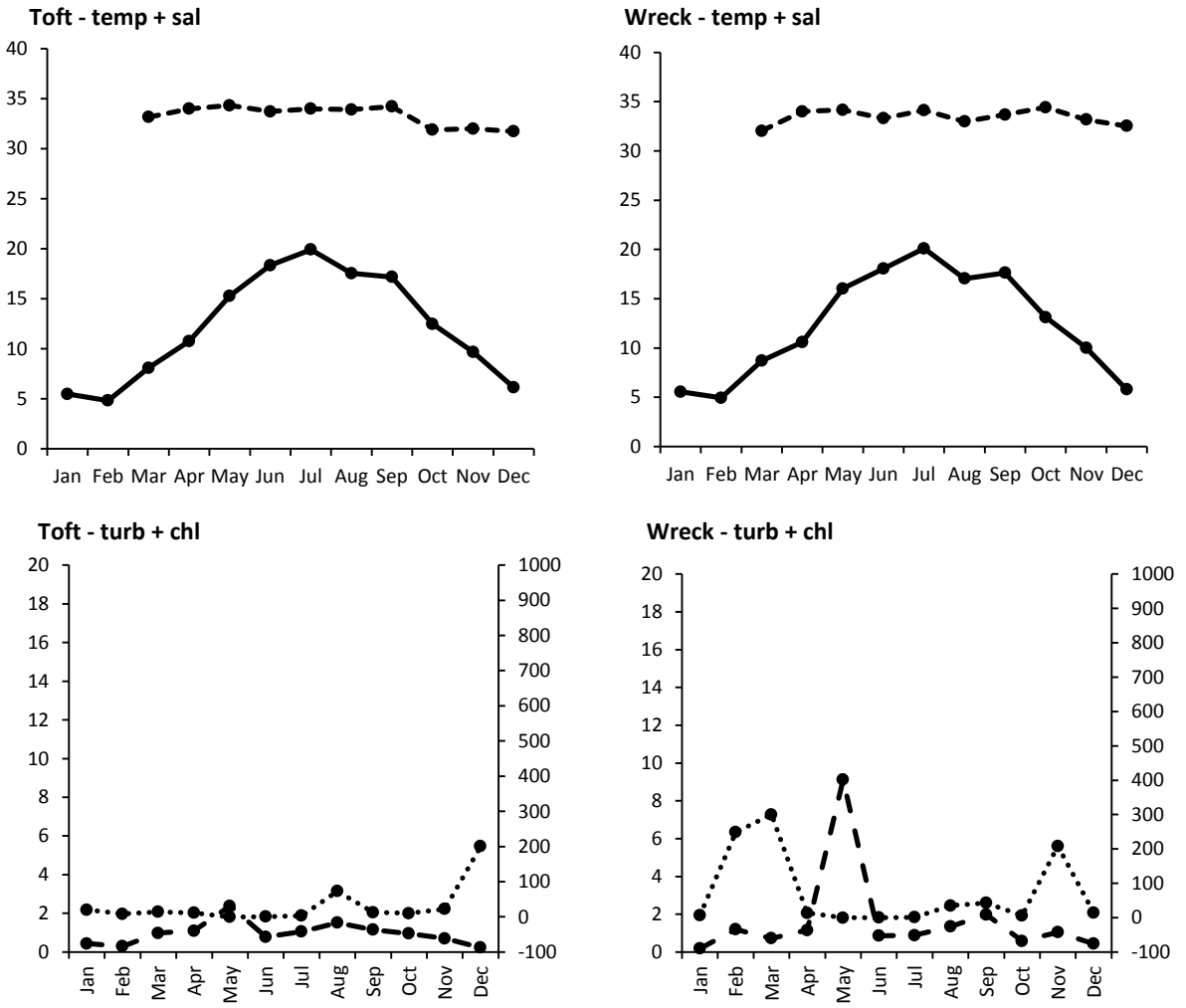


Figure 3 (a). Hand sonde results for the main monitoring sites spanning the entire of 2014. Sites have been separated into two charts for clarity. Where there are two y-axes, the left hand axis denotes chlorophyll and the right hand axis denotes turbidity.

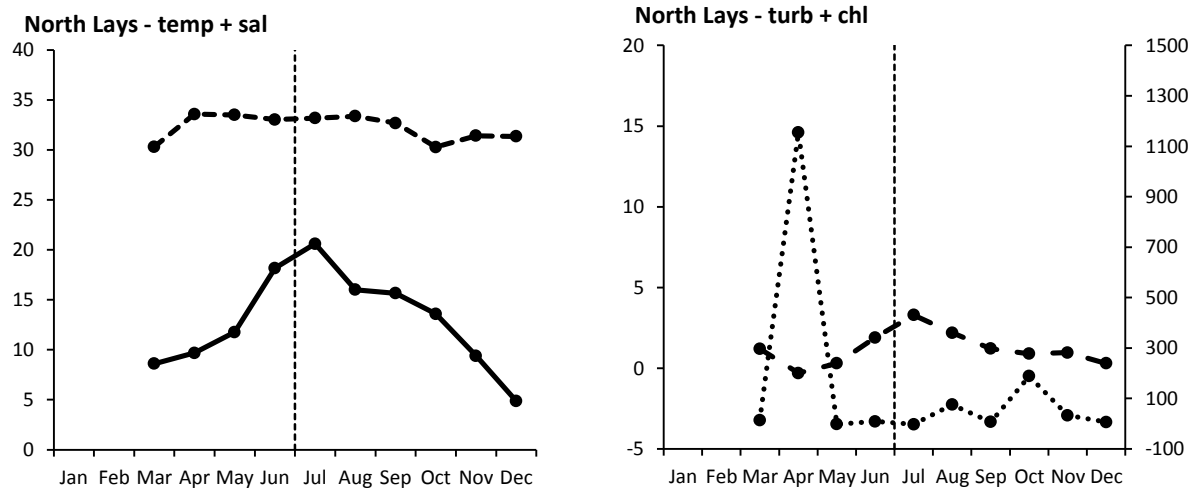


Figure 3 (b). Hand sonde results for the North Lays EHO site, spanning the entire of 2014. Sites have been separated into two charts for clarity. In the right hand chart, the left y-axis denotes chlorophyll and the right hand denotes turbidity. The dashed vertical

line denotes the movement of the site in July to a nearby location following the change in EHO sampling regime.

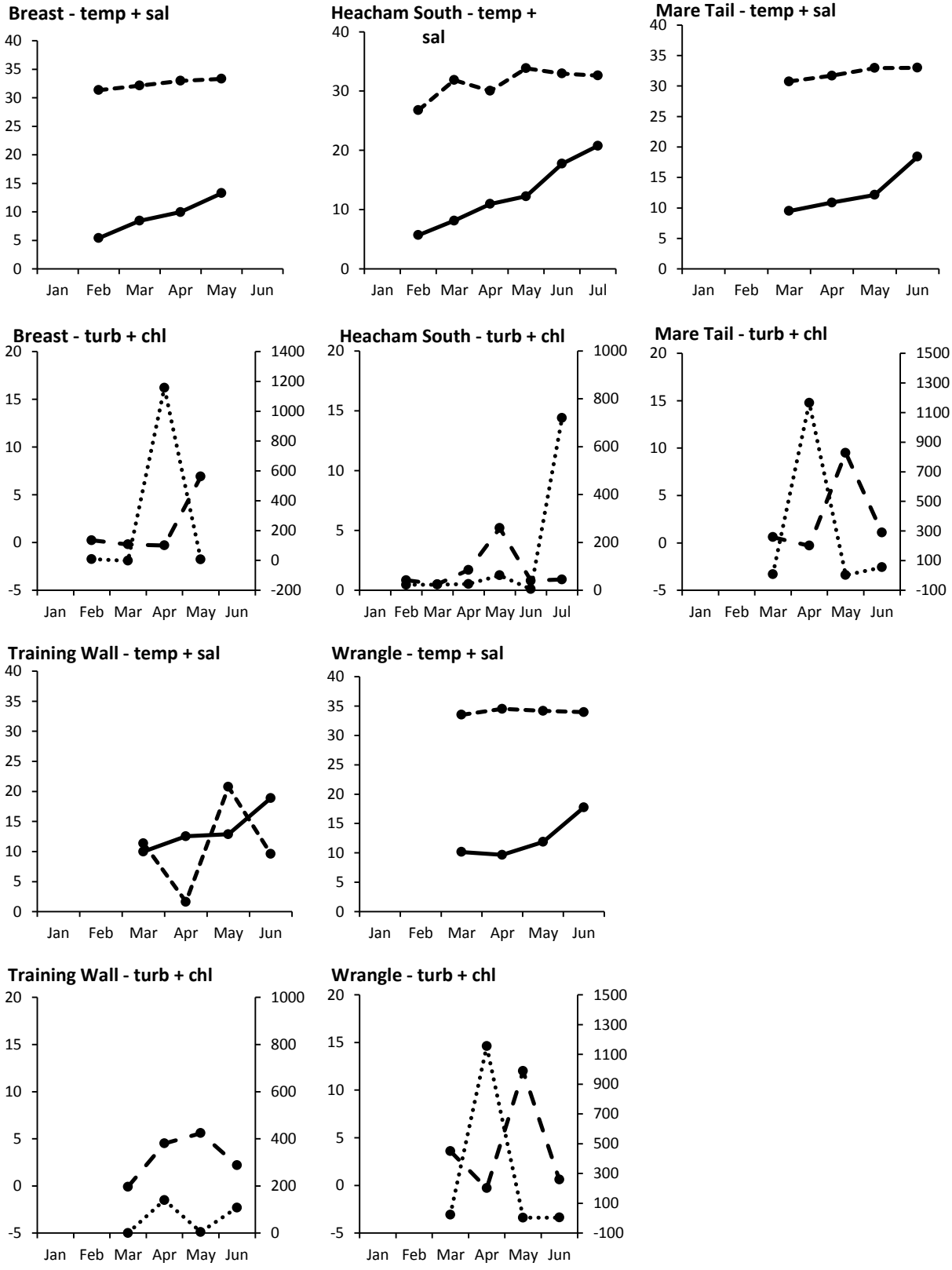
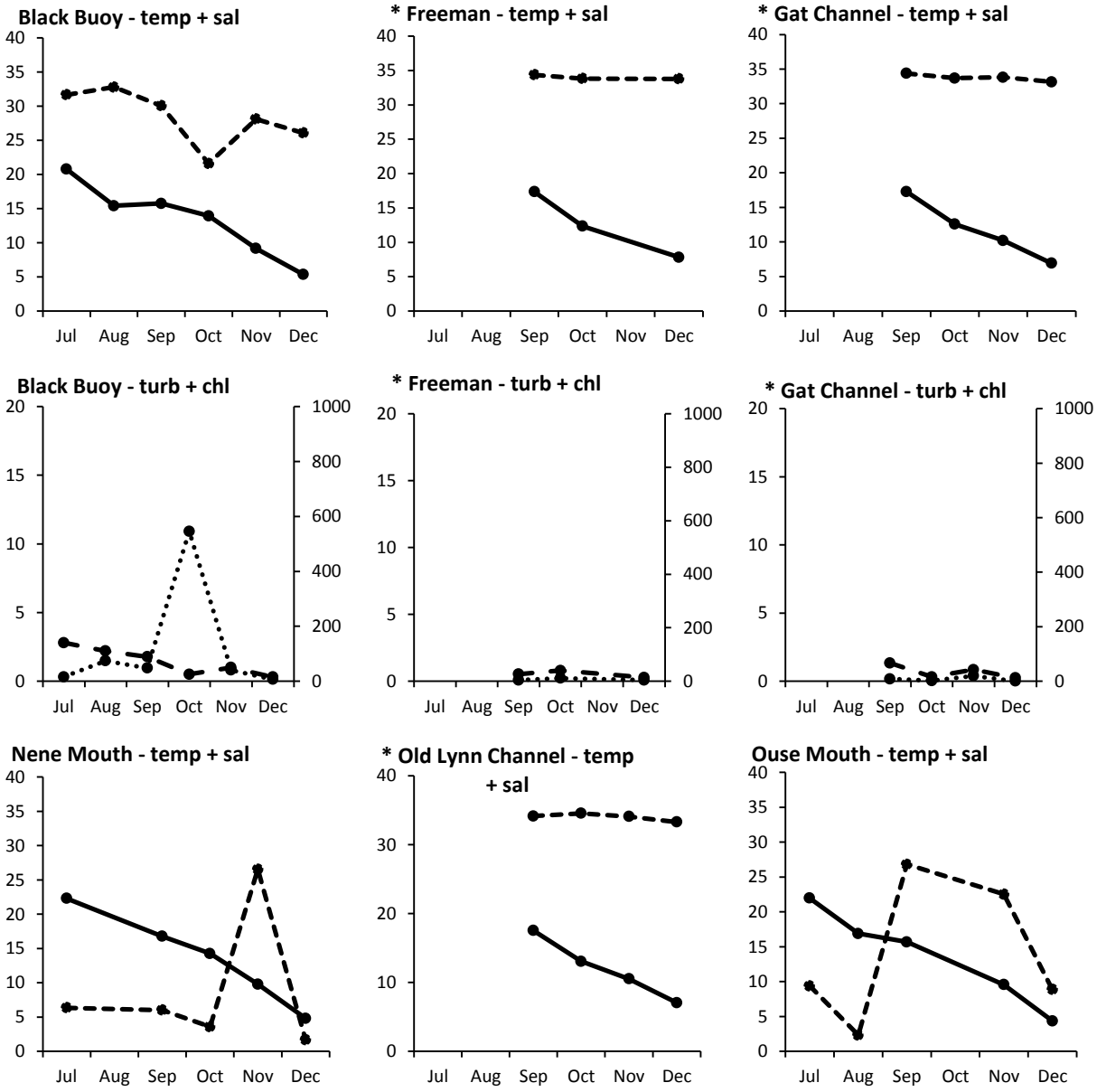


Figure 3 (c). Hand sonde data for sites only monitored prior to EHO sampling regime changes in July (former EHO sites). Sites have been separated into two charts for clarity. Where there are two y-axes, the left hand axis denotes chlorophyll and the right hand turbidity. Note the varying axis scales.



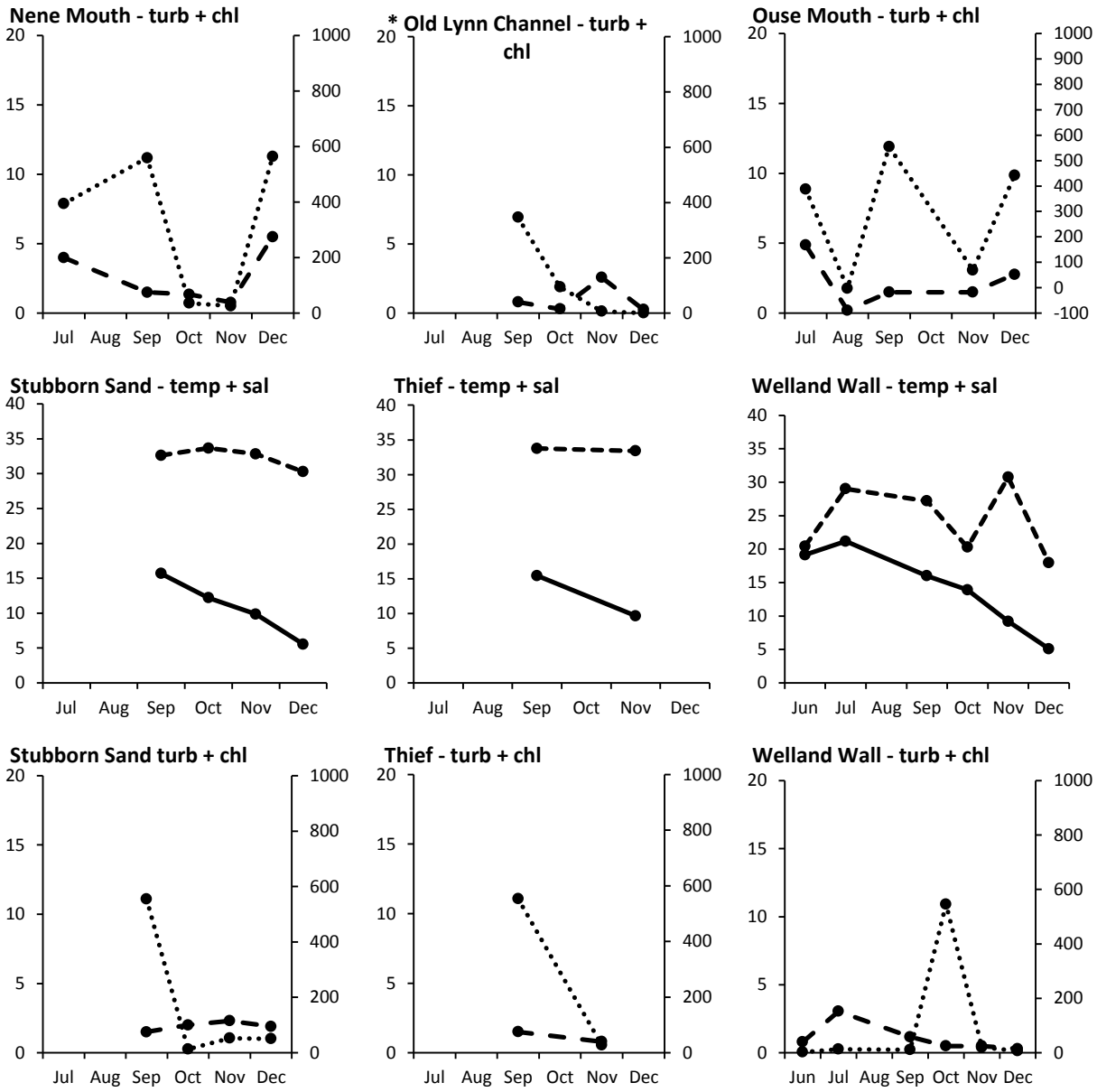


Figure 3 (d). Hand sonde data for sites following changes in EHO and SWEEP sampling regimes (new EHO sites and new SWEEP sites). Sites have been separated into two charts for clarity. Where there are two y-axes, the left hand axis denotes chlorophyll and the right hand turbidity. * Denotes a new main sweep monitoring site. Note the varying axis scales.

Table 2. Mean water quality parameters for various sites in the Wash. Note that not all sites were recorded every month, so averages may not be truly representative of the entire year or the entire of the Wash. Refer to the spot sonde graphs for details of data collected.

	Temperature C	Turbidity NTU	Chlorophyll RFU	Salinity ‰
Black Buoy	13.70	167.99	1.31	27.59
Breast	7.98	197.82	1.18	32.08
Buoy	13.37	9.75	0.91	33.96
Freeman	13.10	6.89	0.57	34.02
Gat Channel	11.99	5.90	0.60	33.74
Heacham	10.87	113.21	1.45	30.20
Mare Tail	16.17	128.88	2.24	32.72
Nene Mouth	12.28	209.36	2.20	9.98
North Lays	13.22	98.06	1.11	32.16
Old Lynn	12.24	108.48	0.85	34.11
Ouse Mouth	15.12	334.15	3.25	12.08
Stubborn Sand	11.10	136.70	1.94	32.60
Stylemans	13.28	125.99	3.11	32.28
Thief	11.11	159.00	0.98	33.50
Toft	12.40	31.16	1.00	33.21
Training Wall	16.52	87.71	2.58	10.14
Welland Wall	14.77	106.04	1.06	25.49
Wrangle	12.26	237.42	5.58	34.07
Wreck	12.65	59.93	1.42	33.58
January	5.59	14.34	0.39	
February	5.14	69.30	0.44	29.06
March	8.42	58.80	0.86	31.41
April	10.64	134.36	1.05	32.84
May	14.65	32.21	7.11	33.62
June	18.05	61.94	1.91	30.04
July	20.54	179.35	2.16	29.75
August	17.43	48.30	1.27	32.20
September	16.78	80.34	1.19	32.27
October	12.91	74.85	0.73	31.03
November	9.91	47.65	1.19	31.55
December	6.33	90.12	0.68	29.61
Mean Wash	12.99	80.04	1.57	31.23
SD Wash	4.88	238.27	2.44	6.40
Min Wash	4.35	-4.00	-0.30	1.63
Max Wash	22.30	2555.20	18.80	34.68

Percent meat yields

Meat yield results can be seen in Figure 4. Whilst every effort was made to obtain a meat yield sample for every site each month, there were times when samples were missed for logistical reasons. The removal of the Gat site was intended to help this by reducing pressure and allowing other sites priority. Gat was chosen as it was the most

consistently missed (only one sample was collected in 2014), and was also deemed the least valuable. Collection success has been higher following the reduction in site numbers, and collection of meat yield samples has since been given high priority.

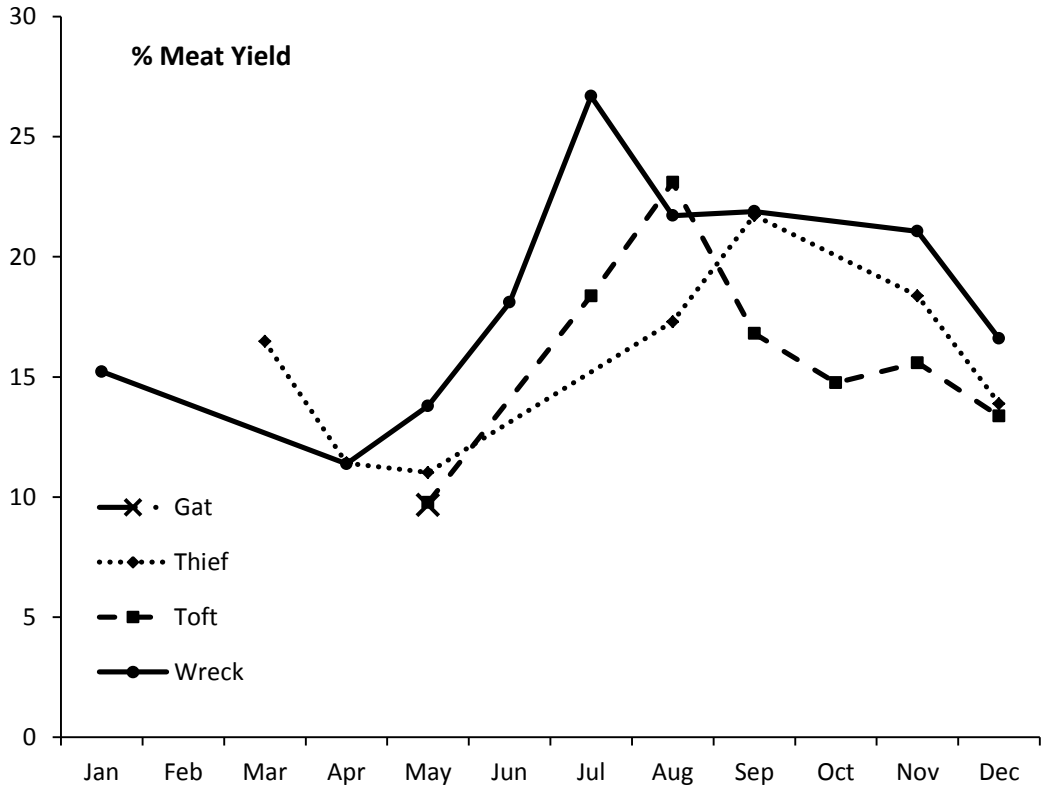


Figure 4. Percentage meat yields of mussels at set locations in the Wash for the year 2014.

From the data available it can be seen that the condition of mussels at all sites (with Gat excepted due to insufficient data) is lowest during spring, peaks during summer, and drops off somewhat through autumn and winter. This pattern is to be expected as spawning occurs in spring, which will cause flesh mass to decrease. Feeding levels are then high through summer causing flesh mass to increase, and low during autumn and winter causing a decrease. Condition of mussels is comparable at Thief and Toft, but generally higher at Wreck. This could be explained by the fact that Wreck is closer to a river mouth (Nene) than the other sites, leading to higher nutrient content in the water and thus higher levels of chlorophyll, e.g. in 2014 the yearly average measure of chlorophyll was 1.42 RFU (peaking at 9.12 RFU in May) at Wreck compared to 1.00 RFU (peaking at 2.38 RFU in May) at Toft. A summary of percentage meat yield statistics can be seen in table 3.

Table 3. Summary statistics for percentage meat yields of mussels at monitored sites in the Wash

Wash mean	16.80
(Standard Deviation)	(4.5)
Minimum	9.66 (Gat, May)
Maximum	26.69 (Wreck, July)

Discussion

SWEEP began as an ambitious project intending to summarise the main aspects of productivity in the Wash, including establishing carrying capacity and a food web. Over the years, however, it has evolved into its current form, which serves as a shellfish water quality monitoring tool. The project places its main emphasis on monitoring chlorophyll levels as a proxy for phytoplankton, and thus food availability for bivalve mollusc populations. The Wash is an important habitat for bivalves, particularly cockles and mussels, which serve both as bird food and fishery stock. For the benefit of both conservation and fishery interests it is therefore necessary to monitor the health of the system in order to identify any threats to bivalve populations. 2014 saw adjustments to the SWEEP sampling regime by the addition of new monitoring sites in order to bolster its power to detect abnormalities in food availability. In 2015 a system of trigger levels will be introduced whereby chlorophyll readings and mussel percentage meat yields below a set threshold on three successive months will result in an obligation for lay holders to reduce stocking density.

During 2013 meat yield sampling was somewhat neglected, leading to a loss of valuable data regarding the condition of mussels in the Wash. During 2014 a greater urgency was placed on collecting the samples and thus more successful collections were achieved. In addition the most consistently missed site (Gat) was dropped during the summer to allow focus to be placed on collecting the remainder of the sites more consistently. This was successful, with a sufficient amount of data being collected in 2014 to observe the yearly trend in mussel condition. A high level of priority has been given to consistent collection of meat yield samples at every site for the future.

As in 2013, difficulties were encountered with the in-situ sonde during 2014 leading to data loss and reduced data quality. The sonde inexplicably stopped recording data on 17 February and did not resume recording until the unit was removed for calibration on 21 April. Salinity readings from the unit shot up on 23 June and remained abnormally high until the unit was later sent for service. This is suspected to be due to a fault in the conductivity sensor. Another unexplained data gap occurred from 23 to 31 August, and it

is likely that this data loss was due to faults in the sonde rather than any external factors. Finally, the sonde ceased recording data as of 23 September after the data buoy broke free of its mooring, as discovered during SWEEP sampling. The buoy was later discovered on Hunstanton beach and both the buoy and the sonde had sustained damage. The sonde was sent for repair and multiple faults were discovered, and it was not returned to the water during 2014. As a result of these difficulties only a limited and somewhat unreliable data set was acquired from the in-situ sonde in 2014, and results should be interpreted with caution.

Hand sonde results were included from both main SWEEP monitoring sites and EHO sample stations. A change in EHO sampling regime in July meant that some sites only have the first half of the year's data, and some only the second. Similarly, three new main SWEEP sites were introduced in July and are therefore presented with only the latter half of the year's data. The result is that a larger number of sites than usual are presented in this report, whereas in 2015 fewer sites will be presented but with higher quality in that the whole year will be presented for every site, allowing for annual patterns to be observed. A caveat regarding the hand sonde data is that each data point is only a single measurement in a dynamic environment (or rather an average of three measurements taken in quick succession), and thus only provide a snapshot of conditions at any given location at any given time. As such, more stable or gradually changing parameters such as temperature and chlorophyll may be reliable, whereas (depending upon specific location) parameters such as turbidity and salinity may change drastically with the weather or tide. This is especially apparent at locations such as river mouths, and in these cases results should be interpreted with caution. Nevertheless the hand sonde is a valuable tool, especially for monitoring chlorophyll, and will allow for the effective use of the aforementioned trigger level system.

References

Jessop *et al*. (2009). Eastern IFCA annual research report 2009.