

APPENDIX 5.2
STATISTICAL ANALYSIS OF RIVER
WATER TEMPERATURE BETWEEN
BYBROOK AND LONGPORT BRIDGE

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**ANALYSIS OF THE DIFFERENCE IN WATER TEMPERATURE BETWEEN
BYBROOK BRIDGE, ASHFORD STW AND LONGPORT BRIDGE.**

The raw data contained different numbers of samples for each sampling location. The data was therefore standardised so that only dates on which temperature was measured from all three sampling points (Bybrook bridge, Ashford STW and Longport bridge) were included (Table 1). This ensured that other conditions which effect water temperature, such as ambient air temperature rainfall input etc, were as similar as possible across the three sites.

date sampled	Month	Bybrook bridge	Ashford STW	Longport bridge
06/01/2000	Jan-00	7.9	9.9	8.1
23/02/2000	Feb-00	6.2	9.9	7
08/03/2000	Mar-00	9.7	11.3	10.4
11/04/2000	Apr-00	7.6	9.4	8
26/06/2000	Jun-00	14.2	16.1	15.6
11/07/2000	Jul-00	14.1	15.8	15
22/08/2000	Aug-00	15.7	18.2	17
20/09/2000	Sep-00	15.1	17.1	15.8
17/10/2000	Oct-00	10.2	12.5	10.2
01/11/2000	Nov-00	9.9	10.8	9.8
06/12/2000	Dec-00	9.9	11.7	10.2
22/01/2001	Jan-01	5.1	8.9	5.6
01/02/2001	Feb-01	5.2	8.3	5.7
03/04/2001	Mar-01	11.33	14.87	11.84
19/04/2001	Apr-01	6.82	9.91	7.49
16/05/2001	May-01	13.88	15.34	14.12
20/06/2001	Jun-01	15.62	17.04	15.9
16/07/2001	Jul-01	14.91	17.71	15.58
20/08/2001	Aug-01	17.09	19.33	18.02
20/09/2001	Sep-01	13.52	15.39	14.14
11/10/2001	Oct-01	11.94	14.33	12.27
14/11/2001	Nov-01	5.79	10.27	6.81
26/11/2001	Nov-01	7.98	11.33	8.49
22/01/2002	Jan-02	8.05	7.69	7.68
27/02/2002	Feb-02	6.81	9.11	7.08
15/03/2002	Mar-02	6.04	9.58	6.37
03/04/2002	Apr-02	13.73	15.72	13.77
16/05/2002	May-02	17.13	18.07	17.62
25/06/2002	Jun-02	17.18	17.43	13.4
12/07/2002	Jul-02	12.83	14.44	13.51
12/08/2002	Aug-02	17.27	19.11	17.65
19/09/2002	Sep-02	15.15	17.51	16.35
03/10/2002	Oct-02	14.3	17.29	15.87
06/11/2002	Nov-02	11.51	13.86	12.15
28/11/2002	Dec-02	9.74	12.94	10.4
29/01/2003	Jan-03	5.44	7.74	5.72
25/02/2003	Feb-03	7.06	11.4	9.12
20/03/2003	Mar-03	8.42	14.43	9.86
09/04/2003	Apr-03	6.52	9.29	7.55
22/05/2003	May-03	13.84	15.65	14.76
09/06/2003	Jun-03	17.29	18.66	18.19
31/07/2003	Jul-03	18.52	19.2	18.34

28/08/2003	Aug-03	16.37	18.63	16.78
30/09/2003	Sep-03	12.09	15.52	12.87
20/10/2003	Oct-03	9.02	11.6	9.83
20/11/2003	Nov-03	11.22	14.05	11.99
15/12/2003	Dec-03	7.11	3.91	4.59
26/01/2004	Jan-04	5.2	9.36	5.7
12/02/2004	Feb-04	7.85	10.94	8.35
22/03/2004	Mar-04	7.52	10.8	7.93
30/04/2004	Apr-04	11.49	13.19	11.86
21/05/2004	May-04	14.62	15.33	14.99
10/06/2004	Jun-04	18.54	18.51	18.77
21/07/2004	Jul-04	18.18	19.41	18.67
No. samples		54	54	54
Mean		11.40222222	13.62574074	11.8662963
Standard deviation		4.168874635	3.808850469	4.203465011
Standard error of the mean (sem)		0.567311981	0.518318898	0.572019135

Table 1: Matched temperature data (°C) used in the analyses. (Blue winter, purple autumn, pink spring and green summer). [Note for ease of plotting (Figure 1) sample taken 03/04/01, is labelled Mar 01 and sample 28/11/02 is labelled Dec 02 – both are highlighted in yellow]

VISUAL DESCRIPTION OF THE DATA

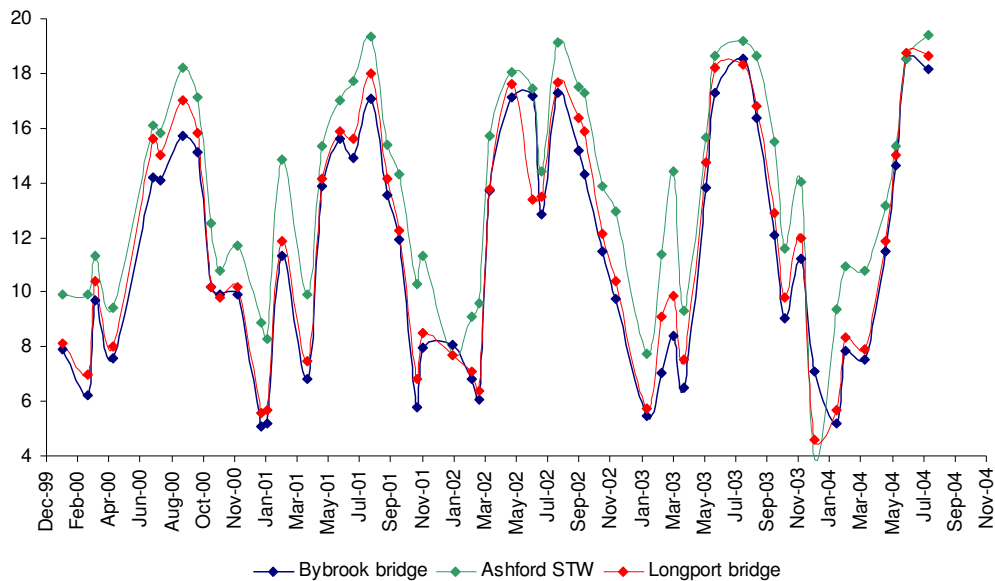


Figure 1: Temperature variation in three sites (matched data from table 1 plotted).

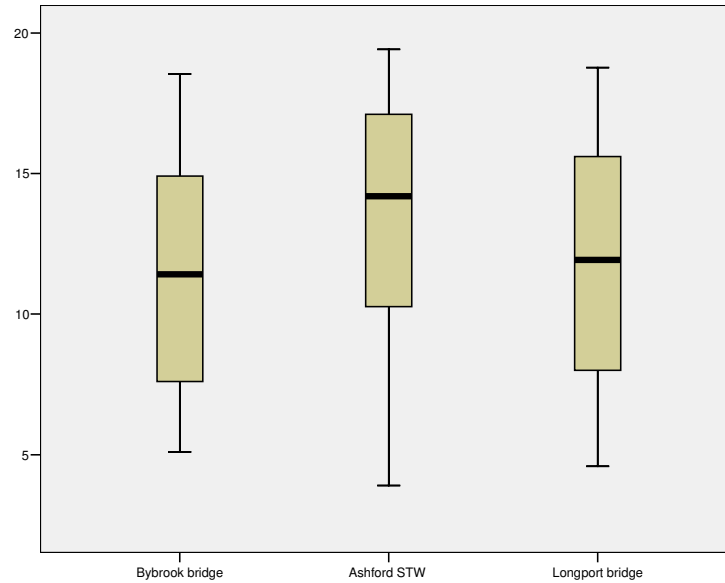


Figure 2: Box plots for Bybrook bridge, Ashford STW and Longport bridge temperature data. (Bold line indicates median temperature, box indicates limit of 2nd and 3rd quartiles, lines illustrate 1st and 4th)

NORMALITY OF DATA

- One sample Kolmogorov-Smirnov procedure (K-S procedure) performed in SPSS vs13.0
- Test statistic is Z
- Significant result ($p < 0.05$) indicates that the data significantly differs from a normal distribution

Bybrook

Z = 0.901, p = 0.391, therefore data is not significantly different from a normal distribution

Longport

Z = 0.763, p = 0.605, therefore data is not significantly different from a normal distribution

Ashford STW

Z = 0.741, p = 0.642, therefore data is not significantly different from a normal distribution

Data do not significantly differ from a normal distribution therefore parametric statistical tests may be performed.

NON PARAMETRIC TESTS

CORRELATIVE RELATIONSHIPS

Spearman Rank Correlation

- Longport, Bybrook and Ashford STW temperatures are all inter-related, see table 2 showing strong positive and significant correlative relationships

	Bybrook	Ashford STW
Ashford	r = 0.943, p <0.001	
Longport	r = 0.979, p <0.001	r = 0.968, p <0.001

Table 2 Summary of the correlations (Spearman product-moment correlations) between Bybrook, Ashford and Longport temperatures (df =52)

Partial Correlation

- As all the temperature variables are inter-related it is difficult to untangle causality. Partial correlation helps to some extent by examining the relationship between two variables whilst holding the effect of a third variable constant. This enables you to examine, for example, the correlation between Bybrook and Longport temperatures if the effect of Ashford STW temperature was 'removed'.

	Bybrook	Ashford STW
Ashford	r = -0.115, Not significant (p =0.413)	
Longport	r = 0.800, p <0.001	r = 0.669, p <0.001

Table 3: Partial correlations between temperature (df =52).

- Longport temperatures are positively correlated with Ashford STW temperatures once the effect of variation in Bybrook temperature are removed. (r = 0.669, p<0.001).
- However there is no significant correlation between temperatures at Bybrook bridge and those at the Ashford STW outfall once the variation in Longport data is removed (r = -0.115, not significant).
- It seems both the temperature at Bybrook and the Ashford STW effluent contribute to observed temperatures at Longport, see figure 3 below for a visual representation of the relationships.

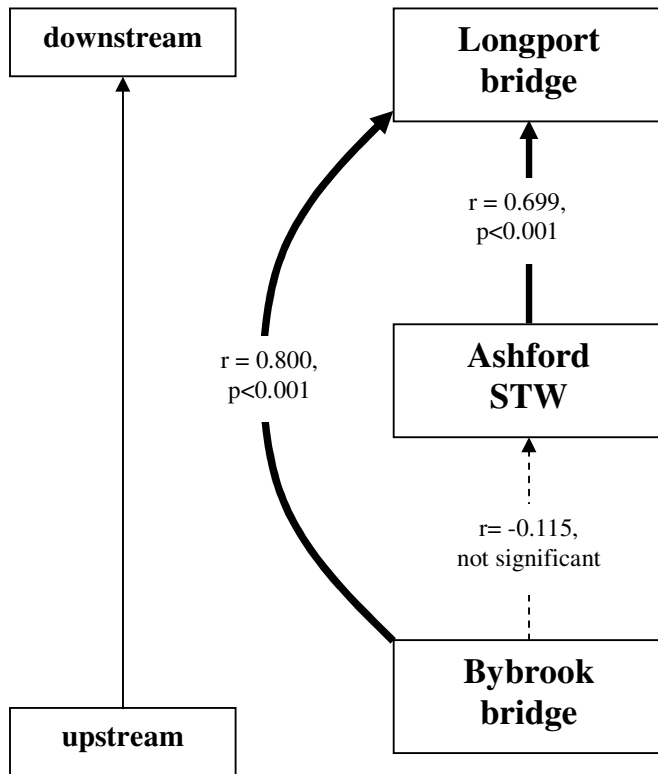


Figure 3: Diagram illustrating significant partial correlations between temperatures at each of the sites. (Line thickness is proportional to the magnitude of the partial correlation.)

OVERALL DIFFERENCE IN TEMPERATURE

One way ANOVA

- One way ANOVA showed that mean Ashford STW temperature was significantly greater than mean temperatures at Bybrook or Longport ($F_{2,159} = 4.498$, $p < 0.05$; Figure 4).

NB

- Variances were homogeneous Levene's test statistic = 0.599, $p = 0.550$
- Post hoc Student-Newman-Keuls test indicated that Ashford was significantly different at $p < 0.05$.

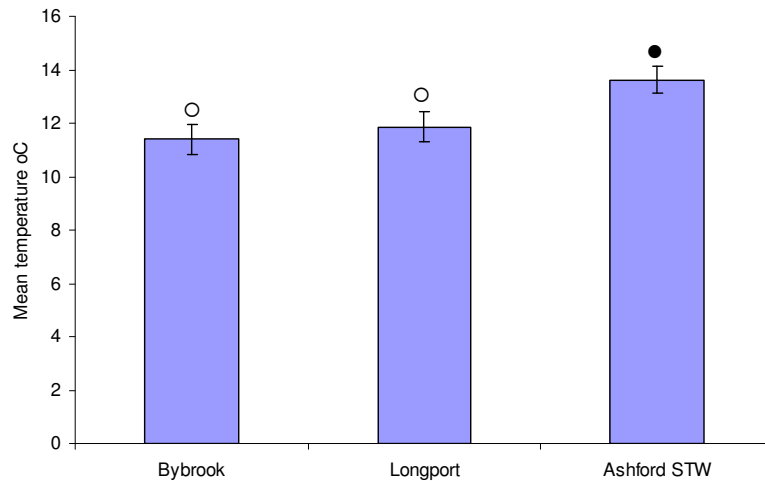


Figure 4: Mean temperature at each site. Different symbols indicate a significant difference was detected by one way ANOVA.

Paired T test

- Results of a paired t test show that mean temperatures at Longport ($11.4 \pm 0.57^\circ\text{C}$) were significantly greater than at Bybrook ($11.9 \pm 0.57^\circ\text{C}$) [$t = -4.019$, $p < 0.001$, $df = 53$]. See figure 5 below.

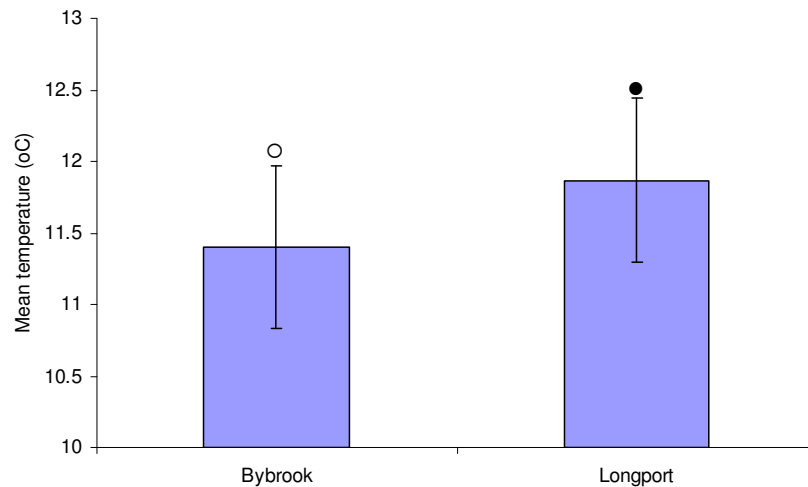


Figure 5: Mean temperature at Bybrook bridge and Longport bridge shown with standard error bars. Different symbols indicate that a significant difference was detected.

Seasonal variation in temperature

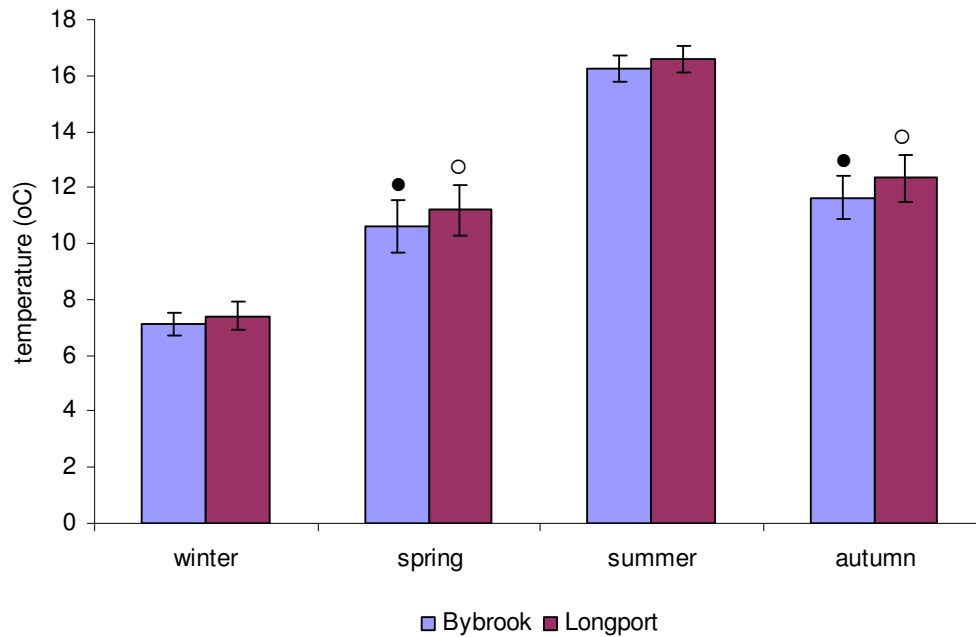


Figure 6: Mean temperature (+/- standard error of the mean sem) at Bybrook and Longport for each season. Different symbols indicate that there is a significant difference in temperature between Bybrook and Longport (see table 5 for test statistics).

	Bybrook mean temp	Longport mean temp	Bybrook sem	Longport sem
winter	7.11	7.409286	0.422961	0.482991
spring	10.61714	11.18286	0.957768	0.931767
summer	16.27143	16.60071	0.473697	0.484594
autumn	11.645	12.34	0.786126	0.835342

Table 4: Mean temperature and standard error data used to construct Figure 6

- **Paired T tests show that mean Longport temperature was significantly greater than Bybrook temperature in Spring and Autumn (Table 5).**

Season	N	t	p
Winter	14	-1.161	Not Significant (p =0.267)
Spring	14	-5.837	<0.001
Summer	14	-0.980	Not Significant (p =0.345)
Autumn	12	-5.144	<0.001

Table 5: Paired t tests comparing mean Bybrook and Longport temperatures for each season.