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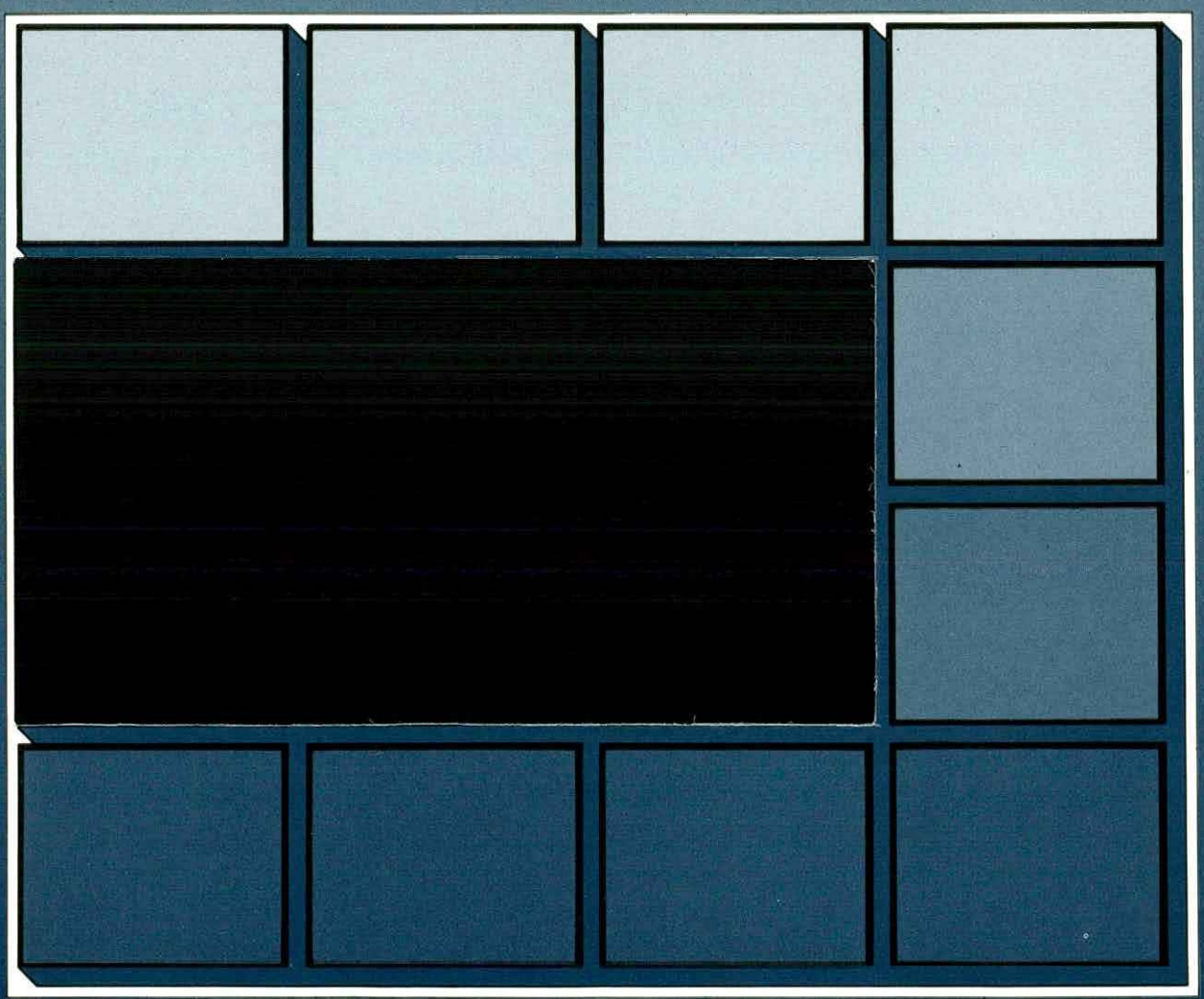

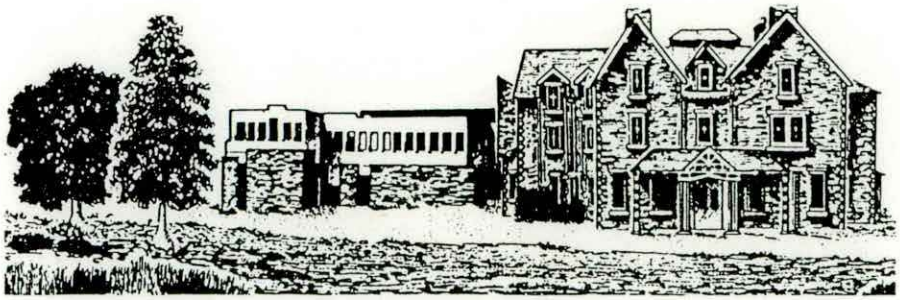

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CHANNEL TUNNEL
Stream survey and assessment in the Folkestone area - summer 1988

P.D. Armitage & R.J.M. Gunn

The Freshwater Biological Association is part of the Terrestrial and Freshwater Sciences Directorate of the Natural Environment Research Council.

CHANNEL TUNNEL PROJECT

FOLKESTONE TERMINAL
AND
ASHFORD CHANNEL TUNNEL DEVELOPMENT

STREAM SURVEY AND ASSESSMENT

IN THE ASHFORD AND FOLKESTONE AREAS

SUMMER 1988

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CONTENTS

1. INTRODUCTION

1.1 In 1987 the invertebrates of 14 sites on streams in the Ashford and Folkestone areas were sampled to provide a base-line to monitor environmental impacts which may arise from construction activity associated with the Channel Tunnel Project. A report describing the results was presented to the clients, Eurotunnel, in October 1987 (Armitage & Gunn 1987).

1.2 On receipt and assimilation of the report by the clients it was felt that any changes in the stream faunas which could develop as a result of construction activities should be monitored further but at a reduced frequency.

1.3 After consultation with interested parties including Mr D.R. Helliwell, terrestrial ecological consultant to Transmanche-Link, it was decided to repeat the sampling of 1987 subject to the possible construction occupancy of some sites. Sampling was initially to be carried out in spring season only and all sites were visited on the 11th and 12th April 1988. A report describing the results of this survey was presented to the clients, Transmanche-Link, in December 1988 (Armitage & Gunn 1989).

1.4 A further survey was subsequently commissioned on the 1st August to monitor the effects of construction activity. Samples were taken on the 2nd and 3rd August 1989 at nine sites using the same method employed in the previous surveys. The results of this summer survey are presented in this report.

2. STUDY AREA

2.1 The characteristics of the Ashford and Folkestone areas have been described in a number of reports which also provide data on water quality, hydrology and possible pollutants. These reports were listed in Armitage & Gunn (1987) and are relisted in this report.

2.2 Site details are also presented in Armitage & Gunn (1987) and need not be reported here. The effects of construction activity at the 14 sites sampled in 1987 (Figs 1 and 2) as of 12th April 1988 are summarised in the report on the spring survey. Any changes since then at the nine sites sampled in the August survey are noted below and additional construction activity is indicated in Fig. 2.

2.3 Saltwood Stream

Site 1 was severely affected by the deposition of silty sand which has probably arisen from construction activity associated with the culverting of the stream. Attempts have been made to contain the silty sand upstream of the trout pond by creating small dams of sand bags and geotextile. These have been effective in retaining some of the sediment which reaches a depth of 15 cm over these areas of stream. Run-off from the denuded slopes of the catchment area is the main mobilising agent for this sediment and subsequent effort was made to intercept the sediment/water prior to its entry to the stream.

Site 2 was unaffected by silty sand deposits and it must be assumed that the small dams and trout pond were effective at retaining the sediment at this time.

Site 3 was similarly unaffected by activity upstream.

2.4 Seabrook Stream

Site 1: suspended material was present in the water at this site giving a cloudy appearance. This had not been observed on the spring sample visit. Attempts to locate the source of this sediment upstream were ineffective.

Construction activity was taking place at site 2 and no samples were taken.

Site 3 was relatively unaffected by activity upstream.

At site 4 there was an apparent increase in deposited sand. The pipeline crossing point is about 200 m upstream and this may have contributed sediment. However, sand deposits were also present above the crossing point. Without more detailed information on sediment origins it is not possible to differentiate between quarry-borne sediment or deposits arising from disturbance of the Seabrook catchment following laying of the pipeline.

Site 5 was unchanged since the April survey.

2.5 Pent Stream

Construction activity at Pent 1 prevented samples being taken in the present survey.

Pent 2 was affected by construction work and in addition to the points noted in the spring survey (light oil on water surface and silt deposits on the stream bottom) there was much silty material in suspension.

Pent 3 showed a slight increase in the proportion of sand in the substratum (estimated percentage cover in April 1988 12% compared with 37% in August).

2.6 The physical features of all nine sites in August 1988 are presented in Table 1. Also included are water quality data collated from information in reports to Eurotunnel from Wimpey Laboratories and information obtained from Southern Water. Estimated alkalinity and chloride values are entered for the Saltwood and Pent streams. Temperature data were calculated using an FBA programme which relates national grid references to climatic information.

3. METHODS

3.1 Faunal sampling and data-processing followed the procedures outlined in the previous report, but collections were confined to the 'summer' season. Sample processing of the preserved fauna took place in the laboratory. The faunas of seven sites (Saltwood 3, Seabrook 1, 3, 4 and 5, and Pent 2 and 3) were identified to family level. However, Hydracarina (water mites) were recorded as such and Chironomidae (midge larvae) were taken to subfamily or tribe level but are referred to as families in the text. Estimates of abundance were made for each 'family' and expressed in five categories according to an approximate logarithmic scale as follows: 1-9 animals = 1, 10-99 = 2, 100-999 = 3, 1000-9999 = 4, ≥10,000 = 5. The fauna of two sites (Saltwood 1 and 2) was identified to species level but some juvenile organisms, dipteran larvae and animals for which no taxonomic keys are available were identified to family or genus level.

3.2.1 Data analysis. The FBA River Laboratory system for the classification and prediction of macroinvertebrate communities in running water (Wright et al. 1984, Furse et al. 1981, 1987, Moss et al. 1987, Armitage et al. 1987) was used to analyse the results obtained during this survey.

3.2.2 Over the past 10 years about 600 species of macroinvertebrate have been identified from more than 400 substantially unpolluted sites throughout Great Britain. The species lists have been used to construct a national classification of running-water sites and to develop a technique for predicting the probabilities of occurrence of individual taxa at sites of known environmental characteristics. This large data base provides a standard against which to assess the fauna of new sites and also places the site in a national context.

3.2.3 Since 1987 the FBA data-base and associated computer package have been modified and whereas initially three seasons data were required to predict the faunal composition of a site from environmental features, now predictions can be made from a single collection. This modified program was used to analyse the data obtained in the 1988 survey. The printout for each site includes the predicted number of taxa and the predicted values for the National Water Council 'BMWP' biotic score (Biological Monitoring Working Party 1978, Chesters 1980, Armitage et al. 1983) and average score per taxon. This is a score system in which score values for individual families reflect their pollution tolerance. Thus high scoring taxa such as some mayflies, stoneflies and caddis indicate good biological quality and low scoring worms and dipteran larvae reflect poorer conditions.

A warning message is shown on screen and printout if, on the basis of the physical and chemical data, the site has a probability of less than 5% of belonging to any of the classification groups.

4. RESULTS

4.1 The occurrence and relative abundance (log categories) of families recorded in 'summer' 1988 at the nine sites are presented in Tables 2, 3 and 4 which also present equivalent data for 'summer' 1987 for comparison.

4.1.1 At two sites the invertebrate fauna was identified to species level and these data are presented in Table 5 and compared with the 'summer' 1987 findings.

4.1.2 Macrophytes were poorly represented at all sites due to a combination of intense shading and unsuitable substratum. The sites on the Saltwood stream and Seabrook 1 and 3 were devoid of water plants. Seabrook sites 4 and 5 had very poor growth of Apium/Berula and no macrophytes were observed in the Pent at sites 2 and 3.

4.2 The ratios of observed to predicted values of score, average score per taxon and family complement at each of the nine sites based on August 1988 data are presented in Table 6.

4.2.1 Single seasons predictions of number of taxa, score and average score per taxon were compared with observed 'summer' 1988 values to derive the indices, I, S and A (Table 6). Values of these indices are shown in Fig. 3 which also presents the equivalent values for 'summer' 1987.

4.2.2 These indices (Fig. 3) provide information on the biological quality of the sites in relation to a standard developed from the FBA data base and can be matched with a chemically-based standard developed by the National Water Council (1981). The NWC system classifies rivers on a 5-point scale with emphasis on their degree of organic pollution (as indicated by BOD and ammoniacal nitrogen values). The five classes are 1A and 1B (good quality), 2 (fair quality), 3 (poor quality) and 4 (bad quality). The NWC bands equivalent to the I, A and S index values are indicated on Fig 3.

4.3 Comparison with a standard provides a measure of the biological quality of the sites on a national scale but any changes within the streams are best indicated by comparing the summer 1987 and summer 1988 data at each site. The ratios of observed 1988 values of biotic score, average score and number of taxa over the 1987 values of these parameters are presented in Fig. 4.

4.4 Saltwood Stream (Tables 2 and 5)

4.4.1 Saltwood 1. Seventeen families (23 'species') were found in the summer 1988 survey as compared with 28 families (34 'species') in 1987. Sixteen

families found in 1987 were absent in 1988 (Table 2). These include all mayflies and stoneflies and four out of five of the caddisflies. Despite this loss of families there were five additions to the summer list but only one of these, the dipteran family Dolichopodidae, was new to the site.

At species level, 21 taxa were lost and 11 gained. Of the 11 (Table 5) 9 are associated with soft sediment (worms, chironomids and Sphaeriidae), one is found on marginal vegetation (the mollusc Zonitoides nitidus) and the flatworm Polycelis felina is widespread in small cool streams (Table 5). A rare and scarce species of worm Rhyacodrilus falciformis was included amongst the gains at this site and it is the first time that this species has been recorded in surveys of all the Ashford and Folkestone streams. It is a stenothermal species usually associated with stony or gravel substratum near hardwater springs. Pisidium milium a 'pea-mussel' (Sphaeriidae) has a widespread distribution but does not occur in large numbers. The species is new to the Saltwood stream but occurs in the adjacent Seabrook system. The 21 losses include three species of mayfly, two stoneflies, four caddis, two water beetles, seven dipterans, a mollusc, a leach and a water mite.

4.4.2 The biological quality of this site was appreciably lower in 1988 than in 1987. Figure 3 shows that the faunal and score indices have dropped from 1A to 2 and ASPT has dropped a class from 1A in 1987 to 1B in 1988. In the spring survey no such deterioration was observed. A direct comparison of 1988 and 1987 summer values of score, ASPT and numbers of BMWP taxa (Fig. 4) show extreme reductions.

4.4.3 Saltwood 2. Seventeen families were recorded in both 1988 and 1987 summer samples. In 1988 there were four additions to the summer list but none were new to the site. The total number of taxa at species level was 21 in 1987 and 24 in 1988. Eight species were new to the summer list. Of these, three are new to the site, Ancylus fluviatilis (mollusc) and Nanocladius sp. and Tvetenia sp. (Chironomidae). All three species are common and widespread. There has been very little change in biological condition (Fig. 3) and all the faunal parameters indicate good quality (1B). ASPT and Score values in 1988 were slightly lower than in 1987 (Fig. 4).

4.4.4 Saltwood 3. Nineteen families were found in the summer of 1988 as against 14 in 1987. Only two families (Rhyacophilidae and Hydropsychidae) were absent from the 1988 collections. Both, however, occurred in the April 1988 samples. Three taxa, Naididae, Hydroptilidae and Chironomini, are new to the site but none are rare.

The biological quality of the site is similar in both years and remains in the 1B/2 band - that is, good to fair quality.

4.5 Seabrook Stream (Tables 3 and 8)

4.5.1 Seabrook 1

Twenty families were found in the 1988 summer sample compared with 16 in 1987. Of the eight gains in family complement between the two sets of summer samples, only Planariidae (flatworms) were new to the site. The biological quality remains good (1A) (Fig. 3) and there appears to have been a slight improvement in 1988 (Fig. 4).

4.5.2 Seabrook 3

The total number of families recorded in the 1988 summer sample was 18 as compared with 22 in 1987. None of the taxa found in 1987 but not in 1988 (see Table 3) are particularly noteworthy. Of the four gains to the 1988 family complement, two - Ceratopogonidae (biting midges) and Beraeidae (a small cased-caddis) are new records for the site. Ceratopogonidae are widespread but Beraeidae, particularly Beraea sp. are most commonly found in cool small stony streams.

The biological quality of this site remains good (1A/1B) with little change between years although the reduced number of taxa recorded in 1988 has caused a slight depression of score. ASPT values indicating water quality remain high (Figs 3 and 4).

4.5.3 Seabrook 4

Only 13 families were recorded in the summer sample in 1988 compared with 23 in 1987. The 11 taxa found in 1987 but not in 1988 include molluscs, worms, leeches, mayflies, beetles, caddis and fly larva. The single taxon - Tanypodinae, recorded in 1988 but not in the 1987

summer sample was not new to the site having been found in the 1987 autumn sample.

The reduced number of families in 1988 results in depressed faunal and score indices (1B to 2) but water quality, as indicated by the ASPT index, remains high, although there is a slight lowering from class 1A to 1B (Fig. 3). When years are compared directly (Fig. 4) reductions are apparent in all parameters.

4.5.4 Seabrook 5

A total of 15 families were recorded in the 1988 summer sample. This compares with 27 found in 1987. Two taxa, Planariidae and Limnephilidae, were not recorded in the 1987 summer sample but were taken in the spring 1987 and spring 1988 surveys respectively. Many of the 14 taxa missing from the summer 1988 survey are not included in the BMWP score system (these include subdivision of the worms, chironomids and less abundant dipteran families). As a result, the biological quality of the site based on BMWP families (Figs 3 and 4) has not deteriorated as much as might be expected from the reduced number of families recorded in the summer of 1988 and the site remains in the 1A/1B banding.

4.5.5 The slight trend in reduced quality observed in this stream in the summer of 1987 from top to bottom was more obvious in 1988 particularly down to site 4 which showed a marked fall in quality. Seabrook 5, although less diverse in family complement than in 1987, did not show extreme reductions in score number of BMWP families or ASPT.

4.5.6 The increased sand deposition observed at Seabrook 4 and upstream referred to in 2.4 has reduced habitat diversity and the number of niches available to the benthic fauna resulting in a poorer list of families. The remaining sites along the Seabrook stream are relatively unchanged.

4.6 Pent Stream (Tables 4 and 8)

4.6.1 Pent 2

The site was overgrown with terrestrial vegetation and the water

discoloured with suspended material. A total of nine families were found in the 1988 summer sample as against 6 in 1987. Seven taxa were additions to the summer list (Table 4) but only Empididae are new to the site. Biological quality is still fair to poor (Fig. 2) but the 1988 summer values of score, numbers of families and ASPT are all greater than in 1987 (Table 7, Fig. 3).

4.6.2 Pent 3

The numbers of families recorded in 1988 and 1987 samples were 13 and 12 respectively. Of the four additions to the 1988 summer list Prodiamesinae (a subfamily of Chironomidae) was new to the site. Biological quality remains in the 'fair' band (2) (Fig. 3). The direct comparison of score, family number and ASPT in 1988 and 1987 shows no change with the ratios of 1988/1987 values all at, or near, unity (Fig. 4).

4.6.3 The Pent Stream, despite increased construction activity upstream, has not deteriorated in quality as compared with summer 1987 values. Most reduction in quality in this stream occurred between spring 1987 and spring 1988.

5. OVERALL ASSESSMENT

5.1 Two previous surveys, in 1987 (3 seasons) and in spring 1988, have been carried out and reported on. The 1987 survey provided the best data-base to make an overall assessment of the 14 sites in the Ashford and Folkestone areas. The spring 1988 survey provided an opportunity to compare the two years as well as monitoring faunal response to construction activity. The present survey was instigated in response to increased construction activity, particularly in the Saltwood catchment.

5.2 In general most sites showed similar biological quality in the two years despite the later date of the present survey, 3rd August in 1988 and 18th June in 1987. Only two sites showed a marked reduction in biological condition due primarily to a change in substratum following deposition of sand. Land clearance in the Saltwood catchment and pipeline laying in the vicinity of Seabrook 4 seem to have been the main sources of sand. Heavy deposition of sand reduces the areas available to colonising benthic fauna and results in a lowered diversity of animal life.

5.3 A comparison of the results from samples at Saltwood 1 in 1987 with those taken in August 1988 show a reduction in both numbers of families recorded and biotic indices.

	June 87	Sept 87	April 88	Aug 88
No. BMWP families	21	15	18	10
BMWP score	110	71	94	41
ASPT	5.2	4.7	5.2	4.1

Observations of the stream at Trucks Hall upstream of a culverting operation showed clear water with little sediment deposition. However, much sand will be carried into the stream by run-off from the disturbed areas surrounding the culvert, unless remedial measures have been taken.

5.4 A similar comparison of the results at Seabrook 4 in 1987 with those taken in August 1988 also show marked reductions in both number of families recorded and biotic indices.

	June 87	Sept 87	April 88	Aug 88
No. BMWP families	15	12	9	8
BMWP score	69	49	32	31
ASPT	4.6	4.1	3.6	3.9

At this site the source of the sediment is not clear because heavy deposits also occur above the pipeline crossing point.

5.5 The observed reductions in biological quality have to be considered in relation to the natural year-to-year variation in the indices. Detailed pre-construction data are not available. However, general experience from a number of unpublished surveys by the FBA in streams in the UK provide some relevant information. Annual variations in numbers of taxa and the BMWP score may vary by about 25% in natural streams but ASPT values in an unperturbed stream do not vary by more than about 6%.

5.6 New taxa continue to be added to individual site lists and these are detailed in sections 4.4, 4.5 and 4.6. However, taxa new to the survey are rare. In the August sampling the worm Rhyacodrilus falciformis was the only species new to the survey. Further identification of samples to species level will result in new records but the overall family list for the area is unlikely to lengthen.

6. CONCLUSIONS

6.1 The faunal composition of most sites has remained similar in both study years. However two sites, Saltwood 1 and Seabrook 4, have suffered reductions in fauna following increased sand deposition. In the case of Seabrook 4 faunal richness was always low but Saltwood 1 had a rich and diverse fauna and this has been severely reduced by sand deposition.

6.2 Remedial measures should include prevention of the movement of soil/sand into the Saltwood and Seabrook valleys by bunds etc and the replanting of denuded areas in order to consolidate the loose top soil after the completion of culverting and earthworks. If these steps are undertaken it is likely that the streams will return to their original state provided that stream discharges remain similar in quantity and pattern, that no pollution incidents occur and that no catastrophic changes (deforestation, change in agricultural practices) take place in the catchment.

6.3 The suggestion made in the April 1988 report that a similar survey be undertaken in April 1989 is repeated here. Such a survey will continue the monitoring exercise started in 1987 and more particularly assess the effects of autumn/winter rains on the mobilization of sediment at the two most affected sites and describe the response of the stream fauna.

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Table 1. Location and summary of the environmental characteristics of the Folkestone sites (August 1988).

Site Name	NGR	Water width (m)	Mean depth (cm)	Velocity (category)#	Boulders & cobbles (%)	Pebbles & gravel (%)	Sand (%)	Silt & clay (%)	Altitude (m)	Longitude (°')	Latitude (°')	Distance from source (km)	Slope (m km^{-1})	Discharge (category)*	Air temperature range (°C)	Mean air temperature (°C)	Total oxidised N_2 (mg l^{-1} N)	Alkalinity (mg l^{-1} $CaCO_3$)	Chloride (mg l^{-1} Cl)
Saltwood 1	TR 1662 3660	1.4	6.0	4	25	64	10	1	45	1.06	51.05	1.7	23.8	1	12.94	10.55	-	250	30
Saltwood 2	TR 1673 3640	1.2	8.0	4	10	58	30	2	40	1.06	51.05	2.0	8.3	1	12.94	10.55	-	250	30
Saltwood 3	TR 1665 3515	2.4	6.0	4	64	30	5	1	15	1.06	51.04	3.3	23.8	1	12.94	10.55	-	250	30
Seabrook 1	TR 1750 3770	0.9	8.0	3	5	74	20	1	57	1.07	51.06	2.0	6.3	1	12.93	10.53	3.50	241	29
Seabrook 3	TR 1810 3671	3.5	8.0	4	34	55	10	1	38	1.07	51.05	3.4	13.9	1	12.93	10.55	2.63	216	59
Seabrook 4	TR 1865 3620	2.3	9.7	3	0	0	100	0	27	1.07	51.05	4.3	10.9	1	12.93	10.54	2.63	216	59
Seabrook 5	TR 1862 3534	3.0	9.7	4	79	15	5	1	10	1.07	51.04	5.5	11.1	1	12.92	10.54	4.52	330	41
Pent 2	TR 2090 3730	0.9	11.0	2	0	0	0	100	38	1.09	51.06	0.9	16.1	1	12.88	10.54	-	250	30
Pent 3	TR 2230 3675	1.9	9.0	3	50	13	35	2	20	1.11	51.05	2.4	9.8	1	12.93	10.55	-	250	30

1 = ≤10, 2 = >10-25, 3 = >25-50, 4 >50-100 cm s^{-1} * 1 = <0.31 $m^3 s^{-1}$, 2 = >0.31-0.62 $m^3 s^{-1}$

Table 2. Saltwood stream. 'Families' recorded in 'Summer' samples in June 1987 (87) and August 1988 (88) together with their relative abundance (log categories).

Family	Saltwood 1		Saltwood 2		Saltwood 3	
	87	88	87	88	87	88
Planariidae	-	1	-	-	-	-
Hydrobiidae	5	3	3	3	2	1
Ancylidae	2	2	-	1	-	-
Succineidae	1	-	-	-	-	-
Zonitidae	-	1	-	-	-	-
Sphaeriidae	1	1	2	3	-	2
Naididae	-	-	-	-	-	1
Tubificidae	2	2	1	1	2	2
Lumbriculidae	1	1	2	2	3	3
Lumbricidae	1	1	1	1	1	1
Glossiphoniidae	1	1	2	2	1	1
Erpobdellidae	1	-	1	1	2	1
Hydracarina	1	-	-	-	-	-
Gammaridae	3	3	4	4	3	3
Baetidae	2	-	2	2	3	2
Leptophlebiidae	1	-	-	-	-	-
Nemouridae	2	-	-	-	-	-
Veliidae	-	-	1	1	-	-
Dytiscidae	1	-	-	-	-	-
Hydophilidae	-	-	-	1	-	-
Scirtidae (=Helodidae)	1	-	1	1	3	3
Elmidae	2	3	2	3	-	-
Rhyacophilidae	-	-	1	-	1	-
Polycentropodidae	1	1	-	-	-	-
Psychomyiidae	1	-	-	-	-	-
Hydropsychidae	1	-	-	-	2	-
Hydroptilidae	-	-	-	-	-	2
Limnephilidae	1	-	1	-	-	1
Lepidostomatidae	1	-	-	-	-	-
Tipulidae	1	-	2	-	-	-
Ceratopogonidae	-	-	-	-	-	1
Tanypodinae	1	1	-	-	-	-
Orthocladiinae	2	2	-	3	2	2
Chironomini	-	1	-	-	-	1
Tanytarsini	2	-	-	4	-	2
Simuliidae	2	-	2	2	1	2
Stratiomyiidae	1	-	1	-	-	-
Empididae	-	1	-	-	2	1
Dolichopodidae	-	1	-	-	-	-

Table 3. Seabrook stream. 'Families' recorded in 'Summer' samples in June 1987 (87) and August 1988 (88) together with their relative abundance (log categories).

Family	Seabrook 1		Seabrook 3		Seabrook 4		Seabrook 5	
	87	88	87	88	87	88	87	88
Planariidae	-	1	1	-	-	-	-	1
Hydrobiidae	1	2	2	2	1	2	3	1
Zonitidae	-	-	-	-	-	-	1	-
Sphaeriidae	1	-	1	1	1	-	1	-
Tubificidae	2	2	2	2	3	2	3	2
Lumbriculidae	-	1	-	2	-	-	3	3
Lumbricidae	1	-	2	1	1	-	1	1
Glossiphoniidae	-	-	-	-	1	-	-	-
Erpobdellidae	-	-	1	-	2	-	2	1
Hydracarina	-	-	-	-	-	-	1	-
Gammaridae	3	4	4	3	2	3	3	4
Baetidae	3	2	3	3	3	2	3	3
Leptophlebiidae	-	-	1	-	1	-	-	-
Ephemeridae	-	2	-	-	-	-	-	-
Nemouridae	-	-	-	-	-	-	1	-
Leuctridae	-	2	-	1	-	-	-	-
Veliidae	-	-	-	-	1	1	-	-
Haliplidae	-	-	-	-	-	-	1	-
Hydrophilidae	-	-	-	-	1	1	-	-
Scirtidae (= Helodidae)	1	1	-	-	-	-	1	-
Elmidae	1	2	2	2	1	-	3	3
Rhyacophilidae	2	2	2	1	1	-	3	1
Philopotamidae	-	-	1	-	-	-	-	-
Polycentropodidae	1	-	1	1	-	-	-	-
Psychomyiidae	2	-	-	-	-	-	-	-
Hydropsychidae	-	1	2	1	-	-	-	-
Hydroptilidae	-	-	-	-	-	-	1	1
Limnephilidae	1	1	1	-	1	-	-	1
Beraeidae	-	-	-	1	-	-	-	-
Sericostomatidae	-	2	-	-	-	-	-	-
Tipulidae	1	1	2	1	2	1	2	1
Ceratopogonidae	-	-	-	1	1	-	1	-
Psychodidae	-	-	-	-	1	1	1	-
Dixidae	-	-	-	-	-	-	1	-
Tanypodinae	-	-	1	-	-	1	1	-
Prodiamesinae	-	2	1	-	3	2	2	-
Orthocladiinae	2	2	2	1	3	1	3	1
Chironomini	1	1	-	-	2	1	1	-
Tanytarsini	-	1	-	-	2	-	1	-
Simuliidae	2	2	2	1	3	2	1	1
Stratiomyidae	-	-	1	1	-	-	-	-
Empididae	-	-	1	-	1	-	1	-

Table 4. Pent stream. 'Families' recorded in 'Summer' samples in June 1987 (87) and August 1988 (88) together with their relative abundance (log categories).

	Pent 2		Pent 3	
	87	88	87	88
Planariidae	1	-	1	1
Hydrobiidae	-	1	-	-
Lymnaeidae	-	-	1	-
Sphaeriidae	3	-	1	2
Naididae	-	-	-	1
Tubificidae	3	2	2	2
Lumbriculidae	-	-	2	2
Lumbricidae	1	-	-	-
Glossiphoniidae	-	1	-	1
Erpobdellidae	-	-	1	1
Gammaridae	-	2	3	4
Baetidae	3	-	3	1
Veliidae	-	-	1	-
Limnephilidae	-	-	1	1
Tipulidae	-	1	-	-
Tanypodinae	-	3	1	-
Prodiamesinae	1	2	-	1
Orthocladiinae	-	2	1	1
Chironomini	-	-	-	1
Empididae	-	1	-	-

Table 5. Saltwood Stream. 'Species' recorded in 'Summer' samples in June 1987 (87) and August 1988 (88) together with their relative abundance (log categories).

	Saltwood 1		Saltwood 2	
	87	88	87	88
TRICLADIDA				
Polycelis felina	-	+	-	-
MOLLUSCA				
Hydrobiidae				
Potamopyrgus jenkinsi	+	+	+	+
Ancylidae				
Ancylus fluviatilis	+	+	-	+
Succineidae				
Succinea sp.	+	-	-	-
Zonitidae				
Zonitoides nitidus	-	+	-	-
Sphaeriidae				
Pisidium casertanum	-	+	+	-
Pisidium milium	-	-	-	+
Pisidium nitidum	-	-	-	+
Pisidium subtruncatum	+	+	+	+
OLIGOCHAETA				
Tubificidae				
Aulodrilus pluriseta	+	+	-	-
Limnodrilus hoffmeisteri	-	+	-	-
Rhyacodrilus coccineus	-	+	-	-
Rhyacodrilus falciformis	-	+	-	-
Tubifex tubifex	+	+	-	-
Tubificidae indet.	-	-	+	+
Lumbriculidae				
Stylodrilus brachystylus	-	+	-	-
Stylodrilus heringianus	-	-	+	+
Lumbriculid indet.	+	-	-	-
Lumbricidae indet.	+	+	+	+
HIRUDINEA				
Glossiphoniidae				
Batracobdella paludosa	-	-	+	-
Glossiphonia complanata	+	+	+	+
Erpobdellidae				
Erpobdella octoculata	+	-	+	+
HYDRACARINA	+	-	-	-
CRUSTACEA				
Gamaridae				
Gammarus pulex	+	+	+	+
EPHEMEROPTERA				
Baetidae				
Baetis rhodani	+	-	+	+
Baetis vernus	+	-	-	+
Leptophlebiidae				
Habrophlebia fusca	+	-	-	-
PLECOPTERA				
Nemouridae				
Amphinemura standfussi	+	-	-	-
Nemoura erratica	+	-	-	-
HEMIPTERA				
Veliidae				
Velia caprai	-	-	+	+
COLEOPTERA				
Dytiscidae indet.	+	-	-	-

	Saltwood 1		Saltwood 2	
	87	88	87	88
Hydrophilidae				
Anacaena globulus	-	-	-	+
Scirtidae (=Helodidae)				
Helodes sp. (=Elodes sp.)	+	-	+	+
Elmidae				
Elmis aenea	+	+	-	+
Limnius volkmari	+	+	+	+
TRICHOPTERA				
Rhyacophilidae				
Rhyacophila dorsalis	-	-	+	-
Polycentropodidae				
Plectrocnemia conspersa	+	-	-	-
Polycentropodidae indet.	-	+	-	-
Psychomyiidae				
Lype sp.	+	-	-	-
Hydropsychidae				
Hydropsyche siltalai	+	-	-	-
Limnephilidae				
Micropterna sequax	+	-	+	-
Potamophylax group	-	-	+	-
Lepidostomatidae				
Crunoecia irrorata	+	-	-	-
DIPTERA				
Tipulidae				
Eloeophila sp.	+	-	-	-
Dicranota sp.	+	-	+	-
Chironomidae/Tanypodinae				
Thienemannimyia group	+	-	-	-
Zavrelimyia group	-	+	-	-
Chironomidae/Orthocladiinae				
Brillia moesta	+	+	-	+
Chaetocladius sp.	+	-	-	-
Nanocladius sp.	-	-	-	+
Tvetenia sp.	-	-	-	+
Chironomidae/Chironomini				
Polypedilum sp.	-	+	-	-
Chironomidae/Tanytarsini				
Micropsectra group	+	-	-	-
Rheotanytarsus sp.	-	-	-	+
Simuliidae				
Simulium ornatum group	+	-	+	+
Simulium noelleri	-	-	+	+
Empididae				
Chelifera group	-	+	-	-
Stratiomyiidae				
Oxycera sp.	+	-	+	-
Dolichopodidae indet.	-	+	-	-

Table 6. Observed (O) and Predicted (P) values of score, average score per taxon (ASPT) and numbers of BMWP taxa/families based on predictions of BMWP families for 'summer' samples, August 1988.

Indices	Score			ASPT			Families		
Sites	O	P	O/P=S	O	P	O/P=A	O	P	O/P=I
Saltwood 1	41	89	0.46	4.10	5.20	0.79	10	18	0.56
Saltwood 2	51	88	0.58	3.92	4.94	0.79	13	19	0.68
Saltwood 3*	48	109	0.44	4.00	5.35	0.75	12	22	0.55
Seabrook 1	90	87	1.03	5.63	4.95	1.14	16	19	0.84
Seabrook 3	73	107	0.68	5.21	5.22	1.00	14	22	0.64
Seabrook 4	31	89	0.35	3.88	4.72	0.82	8	20	0.40
Seabrook 5*	59	93	0.64	4.54	4.92	0.92	13	20	0.65
Pent 2*	20	90	0.22	3.33	4.41	0.76	6	19	0.31
Pent 3	34	91	0.37	3.78	5.11	0.74	9	19	0.47

*indicates the presence of a warning notice on the prediction

Table 7. A comparison of 'summer' values of score, ASPT and numbers of BMWP taxa/families in 1987 and 1988.

Sites	Score			ASPT			'Families'		
	1987	1988	88/87	1987	1988	88/87	1987	1988	88/87
Saltwood 1	110	41	0.37	5.24	4.10	0.78	21	10	0.48
Saltwood 2	57	51	0.90	4.39	3.92	0.89	13	13	1.00
Saltwood 3	44	48	1.09	4.00	4.00	1.00	11	12	1.09
Seabrook 1	68	90	1.32	4.86	5.63	1.16	14	16	1.14
Seabrook 3	86	73	0.85	5.06	5.21	1.03	17	14	0.82
Seabrook 4	69	31	0.45	4.60	3.88	0.84	15	8	0.53
Seabrook 5	67	59	0.88	4.47	4.54	1.02	15	13	0.87
Pent 2	15	20	1.33	3.00	3.33	1.11	5	6	1.20
Pent 3	34	34	1.00	3.78	3.78	1.00	9	9	1.00

Table 8. The total number of 'families' and species (where applicable) in samples obtained in the 'summer' of 1987 and 1988 from sites on the Saltwood (SW), Seabrook (SB) and Pent (P) streams. Also shown are 'families' present in 1987 but not in 1988 (loss), families not present in 1987 but found in 1988 (gain) and the number of families or species new to each site.

Sites	Total number of 'families' 1987	1988	loss	gain	new
SW1	28	17	16	5	3
SW2	17	17	4	4	3
SW3	14	19	2	7	3
SB1	16	20	4	8	1
SB3	22	18	8	4	2
SB4	23	13	11	1	0
SB5	27	15	14	2	0
PS2	6	9	4	7	1
PS3	12	13	3	4	1
	Total number of 'species'				
SW1	34	23	22	11	3
SW2	21	24	7	10	3

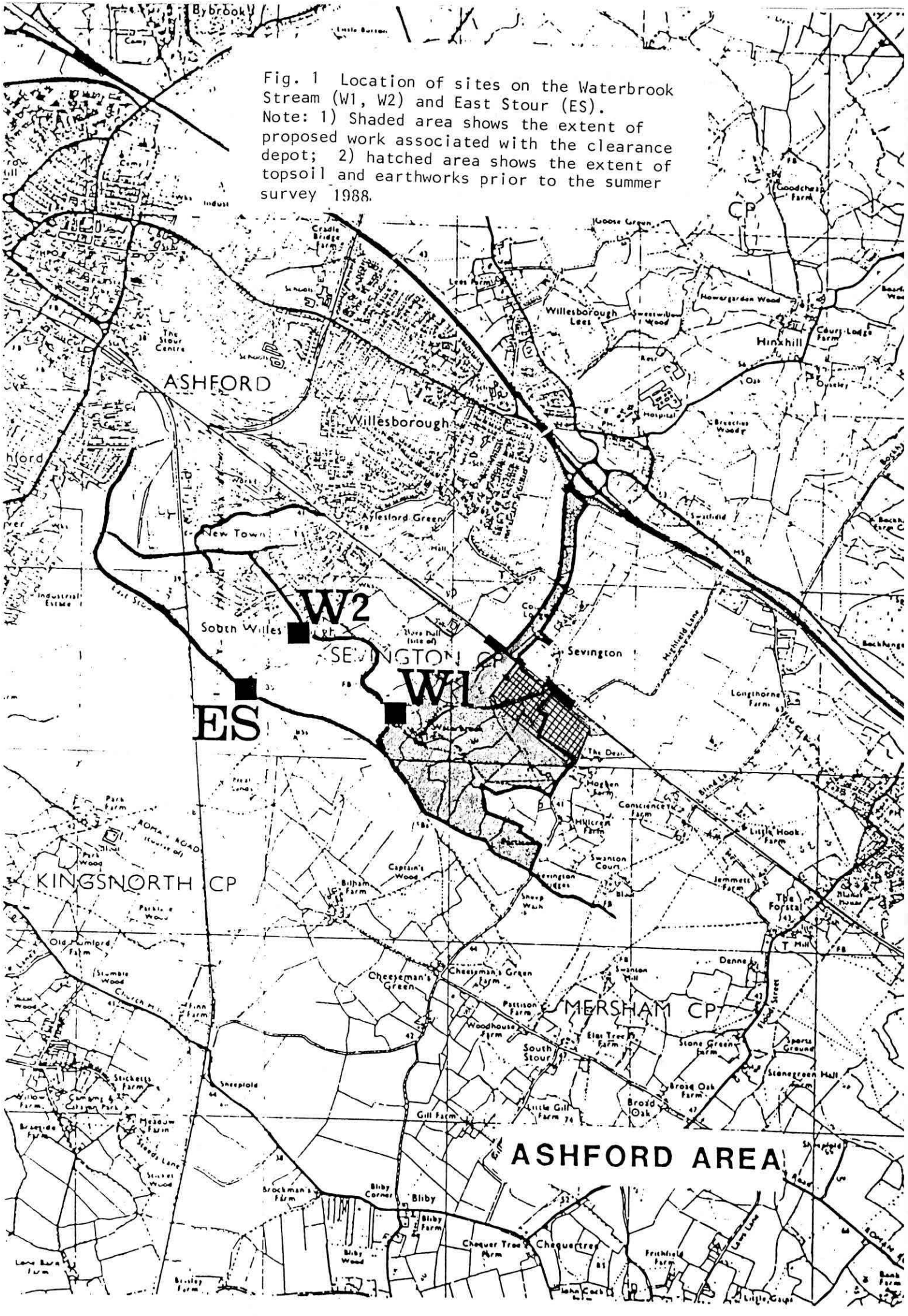


Fig. 1 Location of sites on the Waterbrook Stream (W1, W2) and East Stour (ES).
Note: 1) Shaded area shows the extent of proposed work associated with the clearance depot; 2) hatched area shows the extent of topsoil and earthworks prior to the summer survey 1988.

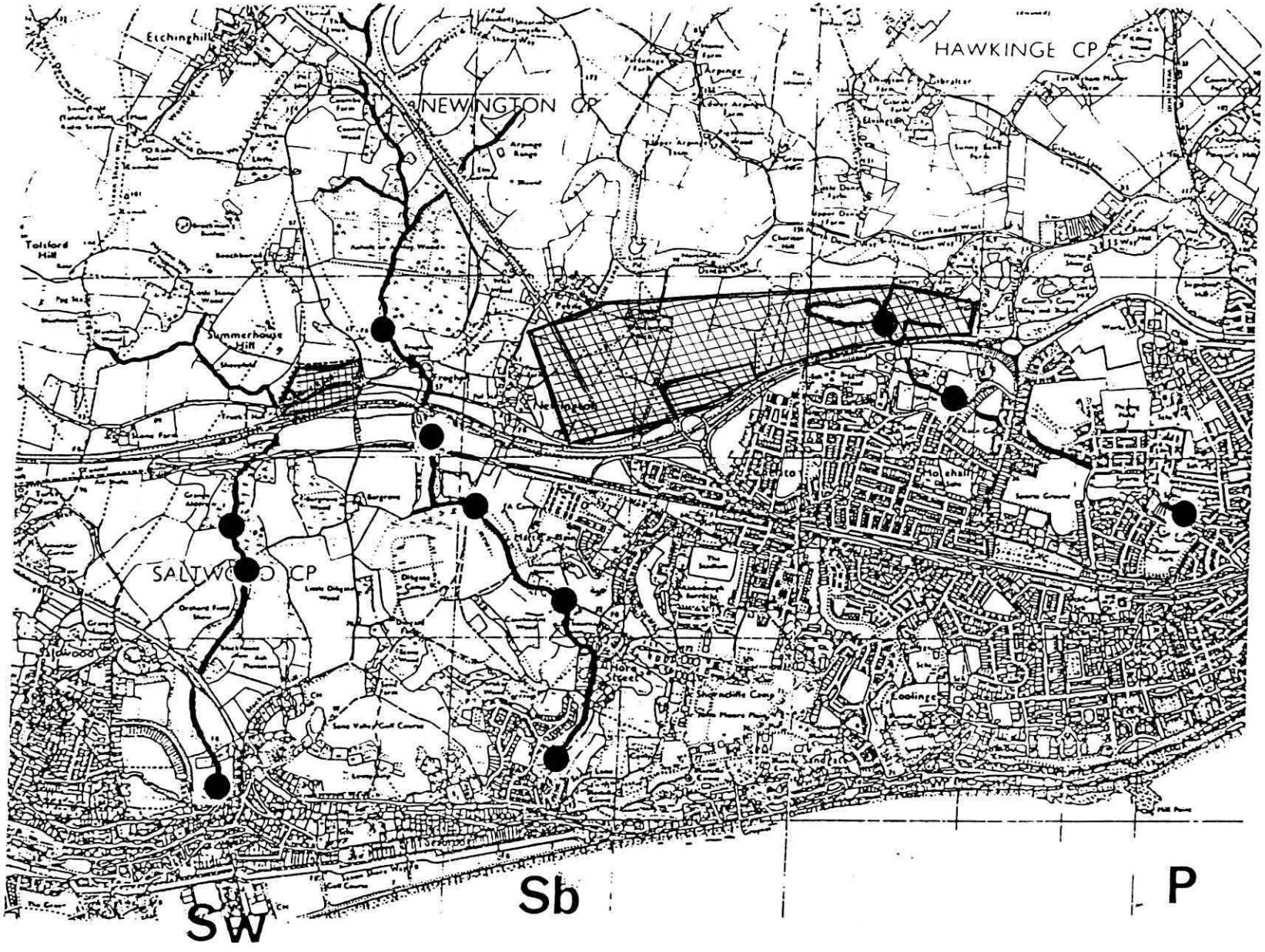


Fig. 2 Location of sites in the Folkestone area (Sw = Saltwood, Sb = Seabrook, P = Pent)
(Hatched areas = topsoil strip prior to summer survey.)

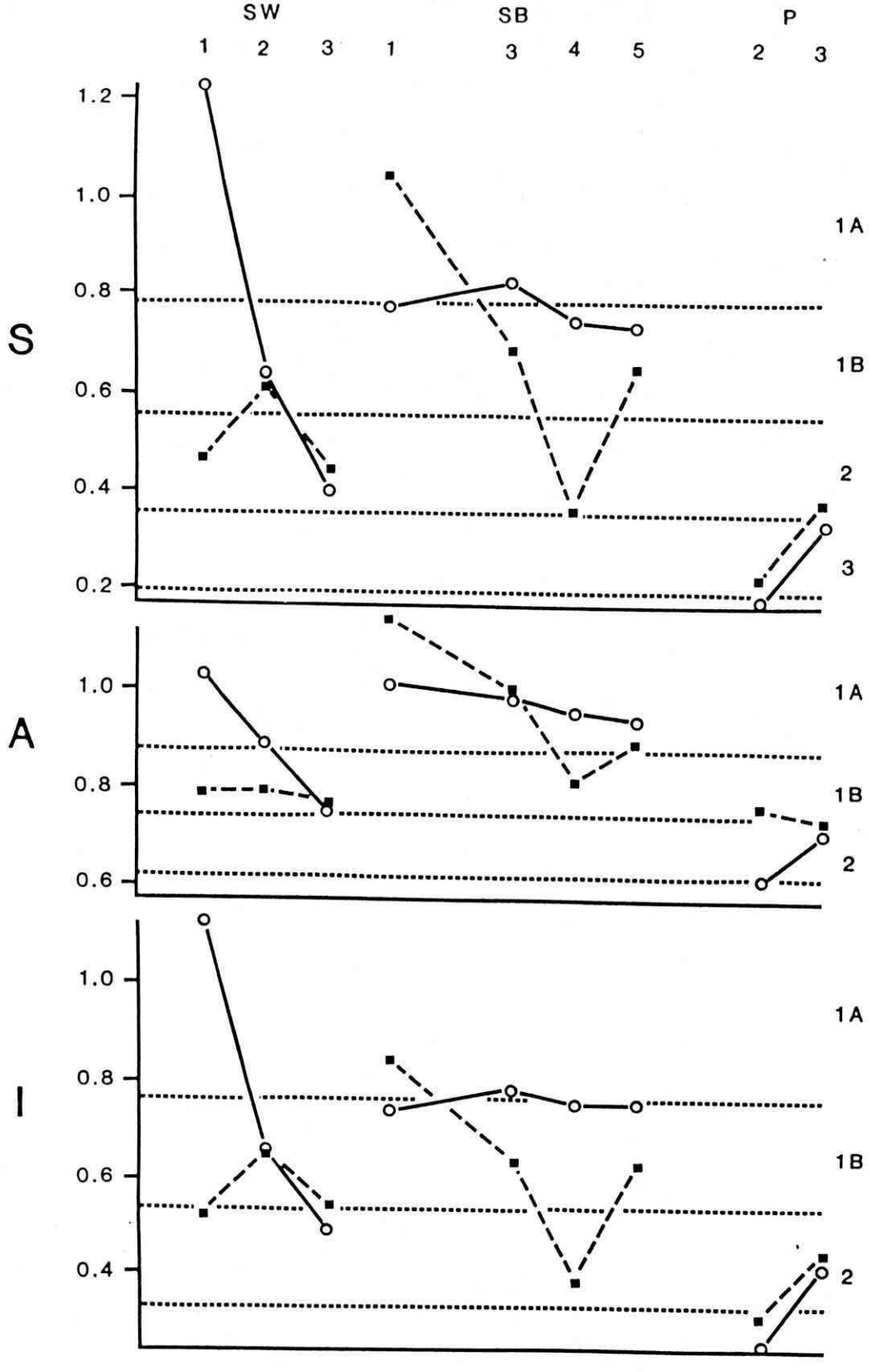


Fig. 3 Variation in index values based on predictions of BMWP families for 'summer' samples. Indices represent Observed value/Predicted values and are presented for Biotic Score S, ASPT A and number of scoring families 1, for 9 sites for summer 1987 (solid line) and summer 1988 (dotted line). (SW = Saltwood, SB = Seabrook, P = Pent).

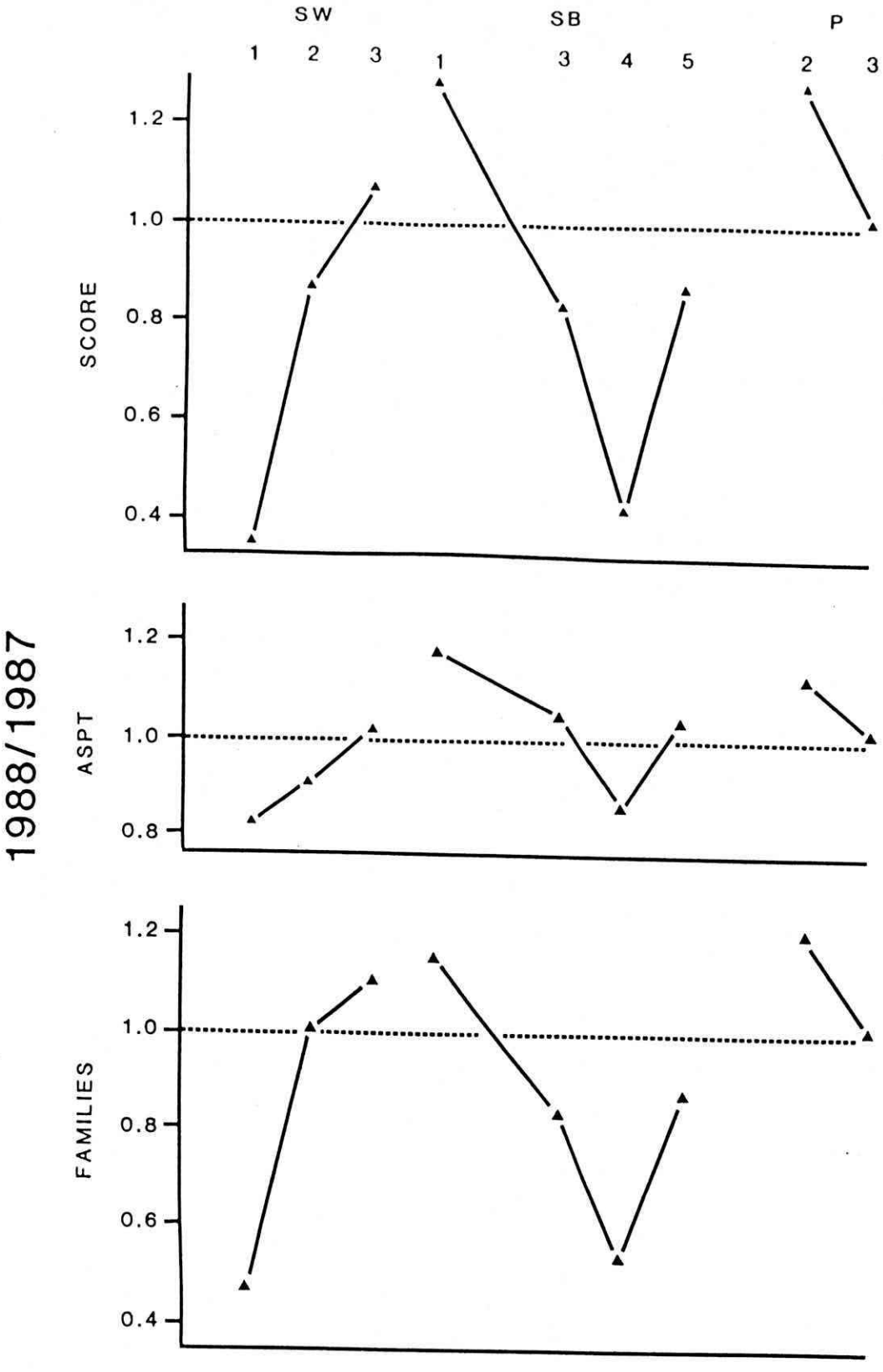
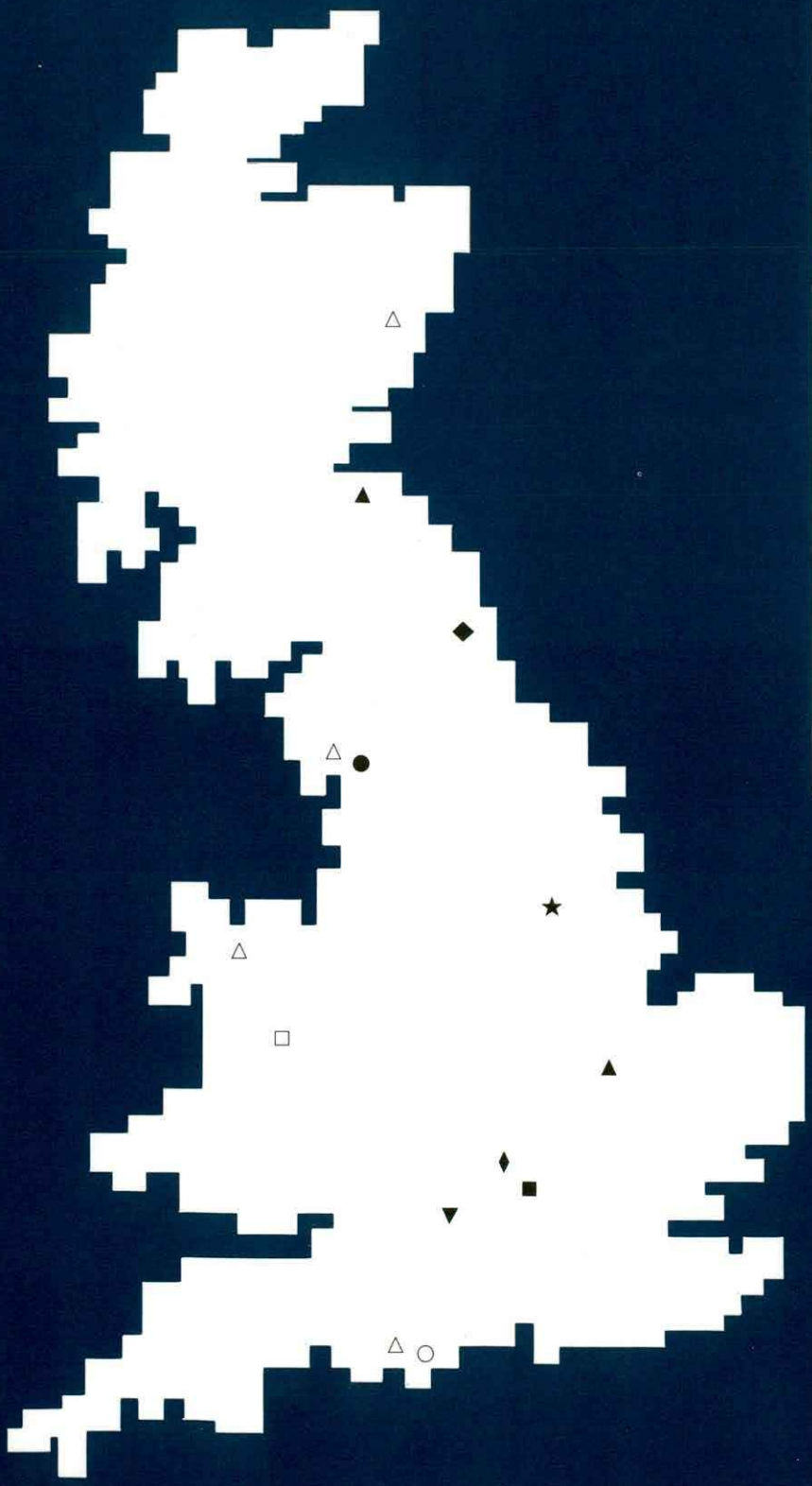


Fig. 4 The ratios of observed summer 1988 values of score, ASPT and numbers of scoring families over the 1987 summer values of these parameters.



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