I.O.S.

SIZEWELL–DUNWICH BANKS FIELD STUDY

TOPIC REPORT 3

M W L Blackley

Beach Changes between Aldeburgh and Southwold March 1978 to May 1979

Report No 90

1979

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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Erratum

page 12, first reference should read :

BASCOM, W N (1951) The relationship between sand size and beach-face slope
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Institute of Oceanographic Sciences
Crossway
Taunton
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SUMMARY

Ten sections spaced at between 1.5–2 km apart were established across the foreshore between Aldeburgh and Southwold and surveyed 14 times between March 1978 and May 1979. These surveys showed the formation of intertidal bars on some sections, perhaps acting as a mechanism for returning sediment to the shoreline from immediately offshore. Greatest sweep volume and elevation changes occurred on Section 3 (Thorpeness) mainly due to these bars.

Volume changes between successive surveys were computed for each section. After 12 months losses were concentrated over the northern Sections 5–11 (north of Sizewell to Southwold). Gains were confined to the southern Sections (1, 3–4 that is Aldeburgh and Thorpeness to Sizewell) and in the far north along Section 12. The position was basically the same at the end of the complete survey. Maximum gains or losses in volume over the 15 month period were equivalent to an increase in height of 0.52 m on Section 4 and a fall of 0.37 m on Section 7.

When all 10 sections were taken together there appeared to be no obvious trend in volume change during the summer. In winter, accretion appeared to be dominant. Greatest volume change occurred in February 1979 which coincided with a period of strong northeasterly winds and associated waves.

The wind pattern agreed with past years with a dominant peak from the southwest and a smaller secondary peak from the northeast. Mean winter wind speeds were higher than in previous years.

On a yearly basis the mean summer significant wave height was 0.34 m compared with a mean winter value of 0.61 m. The winter was particularly rough with 40% of waves measured in December being over 1 m. Dunwich bank appeared to protect the village from the most extreme of the storm waves.

1. INTRODUCTION

1.1 Preface

This is one of a series of Topic Reports concerning specific aspects of work undertaken by the Institute of Oceanographic Sciences in the Sizewell-Dunwich area.

The report describes the data collected during monthly surveys of the beach between Aldeburgh and Southwold during the period March 1978 to May 1979. Sweep zone volumes and the volume changes between successive beach surveys were calculated. Wind and wave records were also compared for the same 15 month period.

1.2 Description of beach

The present day coastline between Aldeburgh and Southwold (Figure 1) alternates between short cliff sections with maximum heights of 20 m OD (Minsmere/Dunwich), 11 m OD (Thorpeness), and tracts of low lying marshland. These preglacial Pleistocene cliff deposits belong to the Norwich Crag Series and mainly comprise soft yellowish/brown marine sands with horizons of shells, gravels and clays. In places these deposits are overlain by glacial sands and boulder clay. The soft nature of the cliffs and the ease with which the sea can gain access to them has led to erosion in places. This is especially so in the Minsmere/Dunwich area where the base of the cliff retreated some 3 m during the survey period.

For the first 4.5 km from Southwold to Dunwich the beach trends northeast-southwest. It then runs virtually north-south until the small headland at Thorpeness is reached. On passing this headland it resumes a southwesterly trend. Where the cliffs are absent shingle has accumulated and now gives some protection to the low lying marshy areas to landward. Just north of Aldeburgh, and between Dunwich and Walberswick, the shingle bank is well defined, having crest heights of 5 m OD and 4.5 m OD respectively. Elsewhere, eg north of Sizewell, the landward side of the foreshore has become vegetated and stabilised. In the past attempts have been made to stabilise the beach by the construction of groynes, notably at Aldeburgh and Southwold. The latter are being raised and lengthened at present. Two other features that interrupt the stretch of coastline are the River Blyth (with its associated harbour jetties) south of Southwold and the smaller outfall sluices at Minsmere and north of Aldeburgh.

The composition of the beach between high water (HW) and low water (LW) varied considerably from month to month and profile to profile. On the whole coarser material predominated at LW where cusps were frequently found. The proportion of sand increased quite noticeably towards the mid-beach position though pebbles were still present as a thin scatter on the surface. Coarser material then increased again over most of the beach towards and beyond the HW mark, the exception being the area immediately adjacent to the cliffs at Minsmere. Here the cliffs acted as an intermittent source of sand size material to the beach.

This distribution of material can clearly be seen during the survey at the end of November (Table 1), when the beach was sampled at HW, Mid-Water (MW) and LW on all 10 sections. The samples contained material of sand size or coarser but only the sand fraction was sieved. Table 1 shows that for LW only the samples on Sections 5, 6, 7 and 8 contained sand (21%-79%). At MW all samples contained some sand (50%-100%) whilst at HW sand grade sediment was restricted to samples on Sections 7 & 11 (68%-100%).

A small tidal range (typically 1.9 m on spring tides) and a predominance of coarse material has resulted in narrow beaches with widths of between 70 m and 100 m and fairly steep gradients (Table 2). The slope of the beach was calculated for each section at the mid-tide position (Bascom 1959) and nearly 80% of the values fell between 1:8 and 1:12. The steepest gradients with a mean of 1:7.7 were found on the predominantly shingle sections (Sections 1 and 8). Section 7 adjacent to the Minsmere cliff had the lowest mean gradient of 1:13 though individual slopes of as little as 1:30 (Section 12) were encountered especially after severe winter storms.

2. OUTLINE OF TECHNIQUES

2.1 Beach Sections

The changes in beach topography were measured on approximately a monthly basis (Table 3) by surveying the sections (Figure 1) which were aligned at right angles to the shore. Initially it was planned to survey 12 sections between Aldeburgh and Southwold spaced at about 1.5-2 km intervals. After a preliminary site visit 2 Sections (9 and 10) in the Walberswick area had to be omitted from the survey due to the difficulty of access, the instability of any bench mark surveyed into the area and particularlv because of the effects of maintenance by the Coast Protection Authority.

The majority of the sections were marked by 2 concrete blocks levelled in on firm ground but some way back from the beach section. Wooden stakes were then placed in line and seaward of the blocks. The most seaward wooden stake marked the beginning of the section, its height being related through the concrete blocks to an Ordnance Survey (OS) bench mark. The line of Section 7 (Minsmere) was marked by an OS triangulation point at the top of the cliff and because the sea periodically reached the foot of the cliff, a telescopic alidade was used to establish a precise distance on the beach for comparison of one survey with another. The sea wall to the north of Southwold provided the control for Section 12.

2.2 Sweep Sections

Sweep zone profiles were drawn for each of the sections and the volumes between the upper and lower beach surfaces measured down to -1 m OD. In order to express the sweep and beach volumes calculations in m^3 it was assumed that the beach profile had a unit width of 1 metre. Profiles were extrapolated to -1 m OD on the occasions that they were not actually surveyed to this depth. These sweep volumes represent the greatest proportion of the beach sediment that was mobilised by wave action during the survey period.

2.3 Computed beach volumes

A simple computer program was used to calculate the volume of material enclosed between successive surveys for each section. The program took surveyed heights at known but irregular distances from the landward limit of the section and by interpolation produced heights at a fixed interval. As the sections were short an interval of 2 m was used. As a precaution against the slope of the beach being nearly horizontal at -1 m OD, the program was instructed to terminate the extrapolation if a given distance from the profile origin was exceeded.

3. OTHER DATA SOURCES

3.1 Wind

The wind data was taken from the Daily Weather records produced by the Meteorological Office for the Gorleston area. This data was in the form of daily vector averages for the 6 hour periods from 0000 h, 0600 h, 1200 h and 1800 h. Wind roses were constructed for the intervals between the 14 surveys carried out between March 1978 and May 1979.

3.2 Waves

As part of the Sizewell-Dunwich Bank study, 3 frequency modulated pressure units were cabled to recorders sited onshore at Aldeburgh, Dunwich and Southwold. All 3 pressure units were located about 150 m offshore, the Southwold and Dunwich recorders in water of mean depth of 8 m and the Aldeburgh recorder in water of just over 6 m depth. Records cover most of the period between spring 1975 and spring 1979. Fortnum and Hardcastle (1979) have shown that for most wave conditions the time series plots of data from the 3 separate recorders are very similar. A more continuous set of data and the relationship of the Dunwich wave recorder to the centre of the research area led to its data being used in this report. Seven and 10 days' data were lost in October 1978 and January 1979 respectively due to delays in replacing the magnetic tapes.

A Waverider was also installed seaward of the Dunwich Bank for the period July 1977 to May 1979. Later in February 1979 a second Waverider was laid landward of the Bank in order to compare the two sets of wave data. To the north of this stretch of coast lies the open North Sea. More immediately offshore the fetch varies between 700–500 km in the northeast quadrant to about 150 km in the southeast quadrant.

4. EVIDENCE FROM BEACH PROFILES

During the survey period (March 1978– May 1979) conditions were such that on occasions an intertidal bar formed on several of the sections, most noticeably on Sections 3 and 7. These bars would seem to be very similar in form to the swash bars described by King and Williams (1949). The bars usually formed after periods of stormy weather. During these periods the beach took on a storm ('winter') profile, and much material was moved offshore. With the onset of calmer conditions the wave steepness decreased and the beach began to form a swell ('summer') profile. The bar formed first in front of the break point of the wave at low water due to the action of the swash/backwash and then migrated up the beach as the tide rose. In this way the bar could be built up above the still water level and could remain until modified or destroyed by higher waves. Landward of the steeper face of the bar, a tidal creek formed.

Figure 2 shows the formation of the swash bars on Sections 3 and 7, and the subsequent infilling of the drainage channel to landward. The base of the creek was 1.2 m below the bar crest in Section 3. Similar events have been reported by

Fox and Davies (1978) on the Oregon Coast. There, bars were formed not only by low waves in the summer but also between major winter storms. The formation and destruction of the bars was not strictly a seasonal phenomenon but was controlled by the frequency and intensity of storms.

4.1 Sweep zone volumes

From the survey data, sweep profiles were constructed (Figure 3), showing maximum height changes over the whole profile down to -1 m OD (Table 4). The greatest sweep volume occurred on Section 3 closely followed by Section 7. These were the two sections on which swash bars were seen. Section 3 also showed the greatest changes in beach height at zero m OD while Section 2 showed the least, and also the least volume change overall.

4.2 Computed beach volumes

As the survey period covered 15 months it was initially split into two parts, March 1978–February 1979 and March 1979–May 1979 in order to enable the volume changes related to a calendar year to be seen separately from the whole 15 months. These volume changes can be seen in Table 5. Except for Section 6, those sections that showed losses or gains of material at the end of March 1979 also showed the same tendency of change at the end of May 1979. On Section 6 however there was a change from erosion to accretion but the amount of material involved was minimal.

After 12 months the losses of material were concentrated in the northern sections (Sections 5, 6, 7, 8 and 11). Gains had been confined to the south except for Section 2, and the mostly northerly section, Section 12. By the end of the survey (May 1979) the position was relatively the same. Section 4 still showed the greatest gain but Section 7 had now replaced Section 11 as the section showing the greatest loss of material. These changes are equivalent to an overall increase in height of 0.52 m on Section 4 and an overall fall in height of 0.37 m on Section 7. During this 12 month period Sections 3, 5 and 6 showed net changes of less than 0.1 m in overall height.

The sections have so far been dealt with separately. Table 6 shows the volume of accretion and erosion that took place between each successive monthly survey, the resultant monthly changes and the cumulative changes. This information is represented diagramatically in Figure 4a and 4b where Figure 4a shows the total volume of material eroded or accreted monthly from the 10 sections (net volume change per month shown hatched) and Figure 4b the change in volume on a cumulative basis over the 15 month period. The greatest net loss of material from the combined 10 sections between successive surveys occurred during November 1978 (1 November–29 November 1978). This does not coincide with the period of greatest volume change of material. This took place in February 1979 (27 January–27 February 1979) when 7 of 10 sections individually showed their greatest volume change. For two other sections it was their second greatest change. Only Section 3 proved an exception, for although the changes at the time were great, movement of the swash bar had resulted in even larger losses earlier on.

The smallest net loss of material was encountered in June 1978 (25 May–20 June 1978) but for individual sections the minimum losses were scattered throughout the summer months, all falling between March and October 1978. The period 21 June–19 July 1978 showed the least volume change.

What does emerge is that the gains and losses of material from the beach as a whole were greater in the winter than the summer months as would be expected although, surprisingly, the net winter trend was accretional. During summer the monthly volume changes seemed to alternate, one month showing accretion, the next erosion.

On an accumulative basis a slightly different picture emerges. Small losses in the early part of the year were balanced out by gains between June and October 1978. During November the beaches suffered a great loss of material and in spite of constant monthly gains during the winter, the balance was not restored until the end of February 1979. Then after some further gains the survey volumes ended in deficit in May 1979.

4.3 Wind Data

The wind rose for the period March 1978–May 1979 (Figure 5) showed that the dominant wind direction was from the southwest quadrant with a secondary peak from just east of north. This agrees with the findings of Craig-Smith and Chambers (1973) who covered a longer period, January 1964–December 1973. During the survey period nearly all the winds greater than 12.9 m/s (25 kn), blew onshore.

Mean hourly wind speeds ranging from zero to 20.0 m/s (39 kn) and gusts of 25.0 m/s (49 kn) were experienced between March 1978 and May 1979. During the summer months (May–October 1978) the mean wind speed was 4.3 m/s (8.4 kn) rising to a mean of 6.8 m/s (13.3 kn) during the winter. The severest winds were experienced on 14–15 February 1979 when the daily mean wind velocity was 18.2 m/s (35.5 kn) and 16 m/s (31.2 kn) respectively, all onshore from the northeast quadrant.

Between surveys S1 and S2 (9 March–24 April 1978) the winds blew from all quadrants but with the strongest winds from the south. Between S2 and S4 (24 April–20 June 1978) the winds were mainly onshore fairly light and from the northeast quadrant. From S4 to S9 (21 June–29 November 1978) the direction changed to offshore and very rarely approached 25 kn. For the next 4 months, S9 to S12, (30 November 1978–27 March 1979) there was a swing back to onshore winds with their strength exceeding 25 kn for over 10% of the time. For the rest of the survey period, S12–S14 (28 March–23 May 1979) the winds became gentler and more variable.

The onshore/offshore pattern is shown clearly by the 2 contrasting wind roses (Figure 6) for the periods 21 June–19 July 1978 and 27 January–27 February 1979. These two intervals also covered the periods of minimum and maximum volume changes for the combined 10 sections. In the first case the offshore winds kept the waves relatively low (Hs 0.32 m) and therefore restricted the movement of material on the sections. In the second case the strong onshore winds, all from the northeast quadrant, resulted in large waves (Hs 0.77 m) and the movement of much greater volumes of material. The larger Hs value obtained for the period 30 November 1978–26 January 1979 appeared to move a lesser volume of material possibly because the strongest winds were from a wider range of directions with the result that although a greater amount of material may have been moved the net measured resultant was smaller, and the charges were integrated over an abnormally long period of time. The largest apparent net loss of material was measured during November 1978 when the waves were moderate (Hs 0.44) and the winds were either offshore or parallel to it.

4.4 Wave Data

The mean and standard deviation of the significant wave height (Hs) and the mean wave period (Tz) were calculated for the intervals between successive surveys (Figure 7). On a seasonal grouping the mean Hs values between May 1978 and May 1979 fall into two, a summer mean value (May–October) of 0.34 m and a mean winter value of 0.61 m. The winter months between December 1978 and February 1979 appear to have been particularly rough as compared to past years. Fortnum and Hardcastle (1979) calculated the mean monthly Hs values for the combined three east coast sites for the period June 1975–May 1977. The mean Hs values that they obtained for the 3 months December–February were 0.50, 0.57 and 0.49 m respectively. The mean Hs values obtained for the same months over the winter 1978/1979 were 0.97, 0.71 and 0.82 m.

The December 1978 beach survey had to be postponed until the following month. In spite of this, and the fact that the waves in January were of a slightly less height, the mean Hs value for this period of 56 days was 0.89 m ± 0.57 m. This figure should be qualified slightly because the first 10 days' wave data in January was missing but from the wind records it would appear that this part of January was no different from the rest of the month. The mean wind speed during these 10 days was 6.5 m/s (12.7 kn) onshore with gusts of over 25.7 m/s (50 kn). This stormy period can be contrasted with the calm of the summer months when between June and October inclusive the mean Hs value fell to between 0.30 and 0.35 m.

Figure 7a also shows the total volume (accretion and erosion) of material moved on the 10 sections between surveys (Table 6) compared with the mean Hs value recorded during the same time interval. It can be seen that in general the greater the Hs value the greater the volume of material moved. However the slightly lower Hs value recorded between 27 January and 27 February 1979 appeared to have moved more material than the maximum Hs figure recorded in the period immediately previous.

All the mean wave period Tz values (Figure 7b) fell between 6 and 7 seconds. The mean for the summer period (6.2 seconds) was just a little less than the winter mean of 6.5 seconds. Waves of period greater than 10 seconds occurred very rarely during the total survey period appearing about 20 times in over 3000 wave period records. However, waves of periods of nearly 15 seconds were recorded in the Dunwich area during the winter of 1975/76 (see Fortnum and Hardcastle 1979).

The percentage occurrence of Hs at increments of 0.25 m during the overall survey period is shown in Table 7. This again emphasises the severe weather experienced in the winter months when 36% and 27% of the waves measured within the 2 periods between the winter surveys (30 November 1978 to 26 January 1979 and 27 January to 27 February 1979) were greater than 1.0 m. The highest Hs value recorded at Dunwich was a little under 2.5 m and this was measured during a severe north-easterly gale at the end of December 1978.

Although the analysis of 2 years of wave data between 1975 and 1977 by Fortnum and Hardcastle (1979) had shown very close agreement between data for the three sites of Aldeburgh, Dunwich and Southwold, waves of the height that occurred in December 1978 and February 1979 were not recorded within this original 2 year period. It now seems likely that waves much in excess of 2 m break on the Dunwich sand bank with the result that the wave data for Dunwich may be deficient in these higher wave values. Other parts of the coast are not so fortunate and waves of 3.22 m were measured at Southwold in mid-February just before part of the pier was demolished.

5. CONCLUSIONS

Sampling of the beach along the lines of section showed that the beach comprised predominantly granule/pebble size material at HW and LW with an increasing percentage of finer material toward the mid-tide mark. Mean beach gradients at the mid-tide mark were steepest (1:7.7) at Aldeburgh (Section 1) and Dunwich (Section 8). At Minsmere (Section 7) the relatively abundant supply of sand from the cliffs caused the beach gradient to be reduced to 1:13.4. This source of sand may also be reflected in the fact that Sections 5, 6, 7 and 8 were the only ones to contain sand in the LW sediment samples.

The formation of intertidal bars on several of the sections provided a mechanism whereby material taken offshore during stormy weather could be brought back under calmer conditions. The presence of these bars on Sections 3 and 7 contributed to these lines having the greatest sweep volumes. Section 2 (just north of Aldeburgh) had the smallest sweep volume.

The wind pattern over the 15 month period agreed with previous years with a dominant peak offshore from the southwest quadrant and a smaller secondary peak onshore from the northeast. The mean wind speeds for December 1978 and February/March 1979 were, however, greater than in previous years.

The mean monthly Hs values for the year May 1978–May 1979 fell into two on a seasonal basis with a mean summer Hs value of 0.34 m and a mean winter Hs value of 0.61 m. The winter was much more stormy than usual. December for example with a mean Hs value of 0.97 m had over 40% of its waves with heights greater than 1.0 m. On the other hand there was very little difference between the summer and winter Tz values, 6.2 and 6.5 seconds, respectively.

The period between surveys was usually just over 28 days but the abandonment of the December 1978 survey resulted in a gap of 56 days. Therefore the volume changes between surveys were the result of varying wind and wave forces acting on the beach profiles for differing time intervals. In spite of this 7 out of the 10 sections showed the greatest volume change of material between Survey 10 and Survey 11 (27 January to 27 February 1979). This was most likely to be attributable to a period of very strong northeasterly winds and resulting waves. Hs values for the previous period had been marginally greater but the winds had had a more varied direction.

The computed monthly volume changes show that, although the volumes of material eroded and accreted were quite large especially during the winter months, the net resultant was small. From the 9 March to 31 October 1978 losses on one month seemed to be balanced out by gains the next. Then, after a great loss of material in November, there was a continual gain on the beaches during the very stormy winter months, though on a cumulative basis these gradual winter gains only just balanced out the November loss.

The volume changes for the individual sections over a 12 month period (March 1978–March 1979) showed that losses were concentrated from north of Sizewell to south of Southwold (Sections 5–11), and to a less extent just north of Aldeburgh (Section 2). Gains occurred on the other sections especially between Thorpeness and Sizewell (Sections 3 and 4). The position was basically the same in May 1979. The maximum gains and losses in material over the 15 month period were equivalent to a gain of 0.52 m on Section 4 and a loss of 0.37 m on Section 7. It was interesting to note that although Section 3 had the greatest sweep volume at the end of the survey period the actual volume of material gained, could be represented by accretion of 0.06 m over the profile length.

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Section Number	Sampling Position		
	HW	MW	LW
1	NS	53 1.67 ± .90	NS
2	NS	80 1.71 ± .50	NS
3	NS	67 1.67 ± .59	NS
4	NS	75 1.81 ± .42	NS
5	NS	79 1.81 ± .43	79 1.71 ± .54
6	NS	82 1.74 ± .47	27 0.14 ± 1.71
7	68 1.38 ± .48	52 0.97 ± 1.38	69 1.70 ± 1.40
8	NS	100 1.81 ± .34	21 1.08 ± 1.01
11	100 1.88 ± .33	87 1.77 ± .47	NS
12	NS	70 1.12 ± .80	NS

Mean grain size (phi units) at the end of November 1978 of sand fraction occurring at HW, MW, LW on 10 sections (NS = no sand present in sample).

Figure at top right of boxes = % of sand in whole sample.

TABLE 1

Section No	Mean gradient at zero m. OD
1	7.7 ± 2.2
2	9.1 ± 1.0
3	11.1 ± 4.5
4	9.4 ± 1.2
5	9.5 ± 1.1
6	10.0 ± 1.9
7	13.4 ± 4.5
8	7.7 ± 1.5
11	10.0 ± 1.8
12	11.3 ± 5.7

Mean beach gradients for the 10 sections during the 15 month survey calculated for the mid-tide position (zero m OD).

TABLE 2

Survey number S.	Duration of survey	
1	7.3. - 9.3.	1978
2	24.4. - 25.4.	
3	24.5. - 25.5.	
4	20.6. - 21.6.	
5	19.7. - 20.7.	
6	16.8. - 17.8.	
7	16 9. - 17.9.	
8	31.10.- 1.11.	
9	29.11. 30.11.	
10	26.1. - 27.1.	1979
11	27.2. - 28.2	
12	27.3. 28.3.	
13	25.4. - 26.4.	
14	22.5. - 23.5.	

Number and date of beach surveys

TABLE 3

Section number	Sweep Volume(m^3)	Max height change at zero m OD	Max height change over whole section
1	45.5	1.15	1.40
2	25.5	0.40	1.20
3	86.0	1.75	2.45
4	53.0	1.55	1.55
5	40.0	0.75	1.00
6	60.0	1.20	1.20
7	83.5	1.25	1.50
8	44.0	1.70	1.70
11	71.0	1.50	1.60
12	69.0	1.30	1.85

Volumes and maximum height changes in metres (at zero m OD and overall) calculated from the constructed sweep zone profiles for the period March 1978 to May 1979

TABLE 4

Section number	Mean Section length m	net Volume change (m^3)		Equivalent height change (m)	
		9.3.78 / 27.2.79	9.3.78 / 23.5.79	9.3.78 / 27.2.79	9.3.78 / 23.5.79
1	49	9.8	10.7	0.19	0.20
2	50	-15.5	-11.5	-0.31	-0.23
3	67	30.1	4.8	0.38	0.06
4	49	41.1	28.7	0.75	0.52
5	65	-3.6	-5.3	-0.05	-0.08
6	60	-1.3	1.7	-0.02	0.03
7	77	-23.4	-31.8	-0.27	-0.37
8	47	-10.2	-16.2	-0.20	-0.32
11	66	-30.6	-15.2	-0.40	0.20
12	59	2.1	18.7	0.30	0.25

Changes in volume (m^3) and the corresponding equivalent height values for individual sections for the year March 1978 - March 1979 and the whole survey period March 1978 - May 1979.

TABLE 5

Date Year	Accretion + (m^3)	Erosion- (m^3)	Total change (m^3)	Cumulative change (m^3)
9/3 - 24/4 1978	60.4	68.9	-8.5	-8.5
25/4 - 24/5	63.2	57.8	+5.4	-3.1
25/5 - 20/6	43.9	46.6	-2.7	-5.8
21/6 - 19/7	52.7	23.5	+29.2	+23.4
20/7 - 16/8	33.5	81.1	-47.6	-24.2
17/8 - 16/9	71.4	26.1	+45.3	+21.1
17/9 31/10	47.3	64.0	-16.7	+4.4
1/11 - 29/11	51.8	122.2	-70.4	-66.0
30/11 26/1 1979	106.5	82.0	+24.5	-41.5
27/1 - 27/2	155.0	115.3	+39.7	-1.8
28/2 - 27/3	81.3	76.3	+5.0	+3.2
28/3 - 25/4	53.4	42.8	+10.6	+13.8
26/4 - 23/5	24.9	56.0	-31.1	-17.3

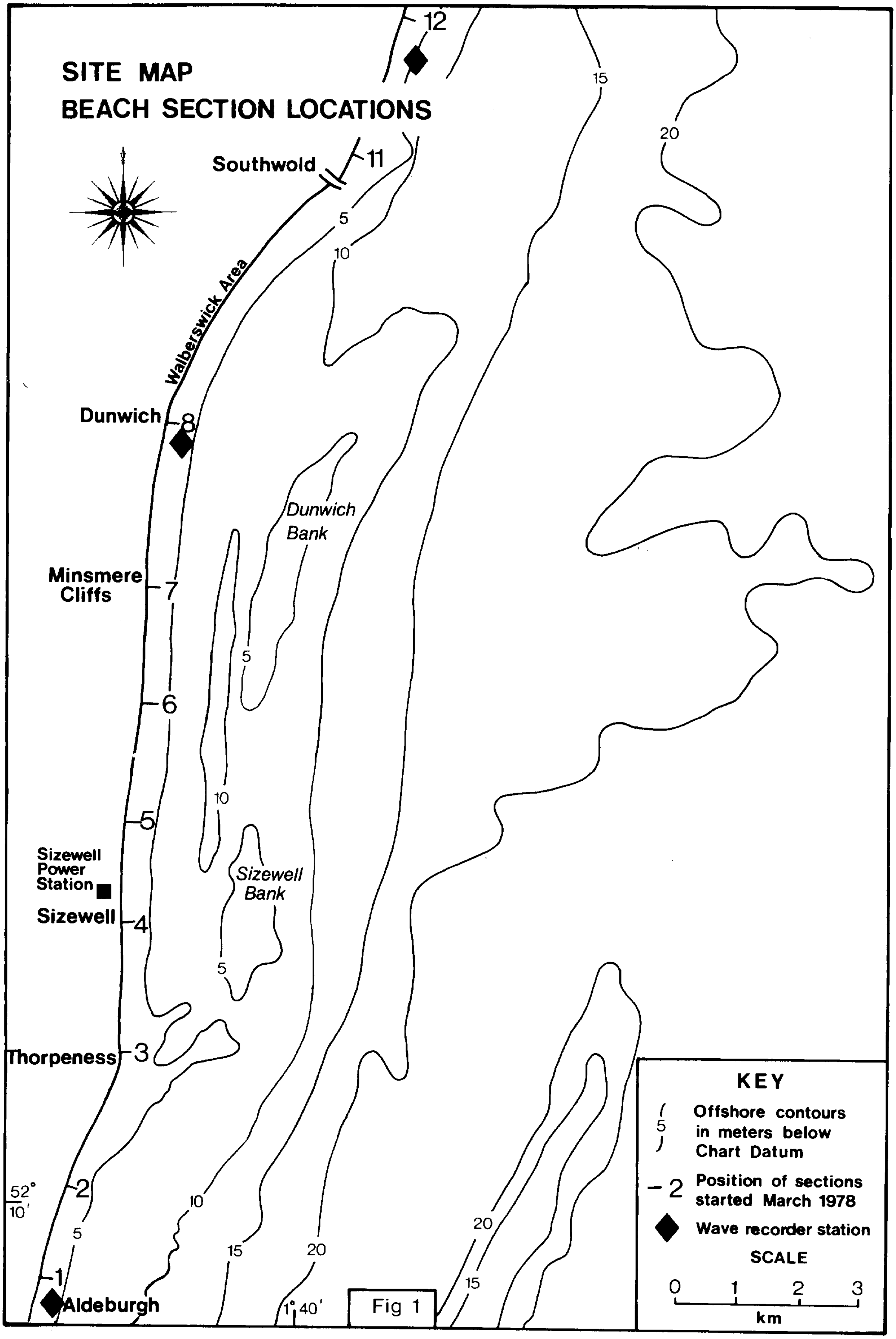
Volumes of accretion/erosion, resultant and cumulative volumes (m^3) recorded between each survey for the period March 1978 - May 1979.

TABLE 6

Significant wave height (Hs)	Number of Surveys												
	1	2	3	4	5	6	7	8	9	10	11	12	13
3.0 m													
2.75													
2.50													
2.25									1	1.5			
2.0									3.5	2.5	1		
1.75									7	4	1		
1.50	0.5						0.5	0.5	9	11	1.5		
1.25	1.5	1.0	0.5				1	1.5	7	4	4.5		
1.0	7	2	1.5		1		0.5	6	8	4	8.5	0.5	
0.75	8	8	3		5	2	1	7	7	10	8.5	4.5	
0.50	21	23	11	5	9	19	6	13	24	14	20	16	
0.25	47	39	30	69	49	48	47	40	32	36	35	49	
0	15	27	54	26	36	31	44	32	1.5	13	20	30	

Percentage occurrence of significant wave height (Hs) in increments of 0.25m between successive surveys.

TABLE 7



SITE MAP
BEACH SECTION LOCATIONS
Southwold
Walberswick Area
Dunwich
Dunwich Bank
Minsmere Cliffs
Sizewell Power Station
Sizewell
Sizewell Bank
Thorpeness
Aldeburgh
52° 10'
1° 40'
12
11
8
7
6
5
4
3
2
1
5
10
15
20
KEY
Offshore contours in meters below Chart Datum
Position of sections started March 1978
Wave recorder station
SCALE
0 1 2 3
km

Fig 1

Profiles showing the formation and subsequent movement of intertidal bars on Sections 3 and 7

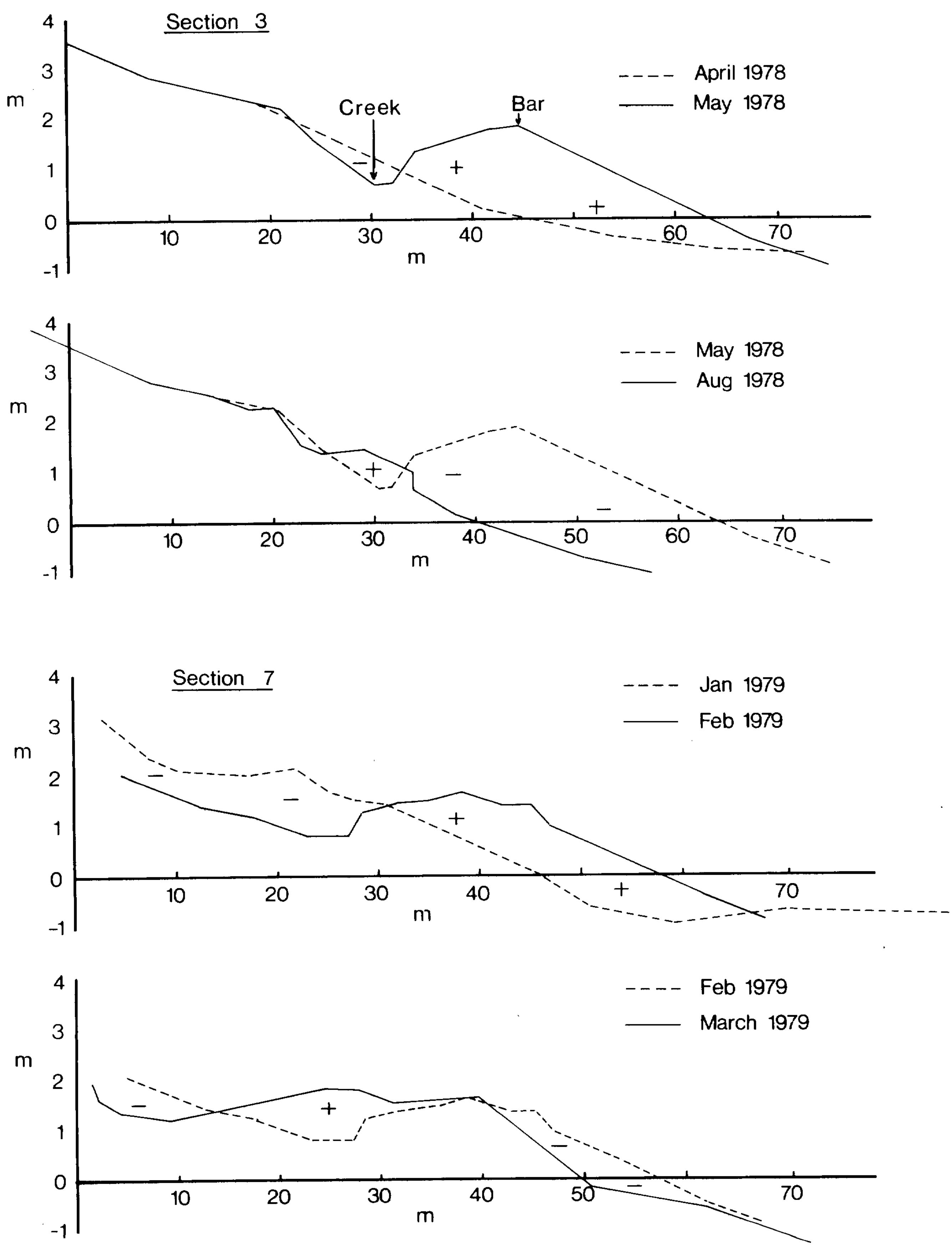


Fig 2

Sweep profiles for the 10 sections derived from the survey data collected between March 1978 and May 1979

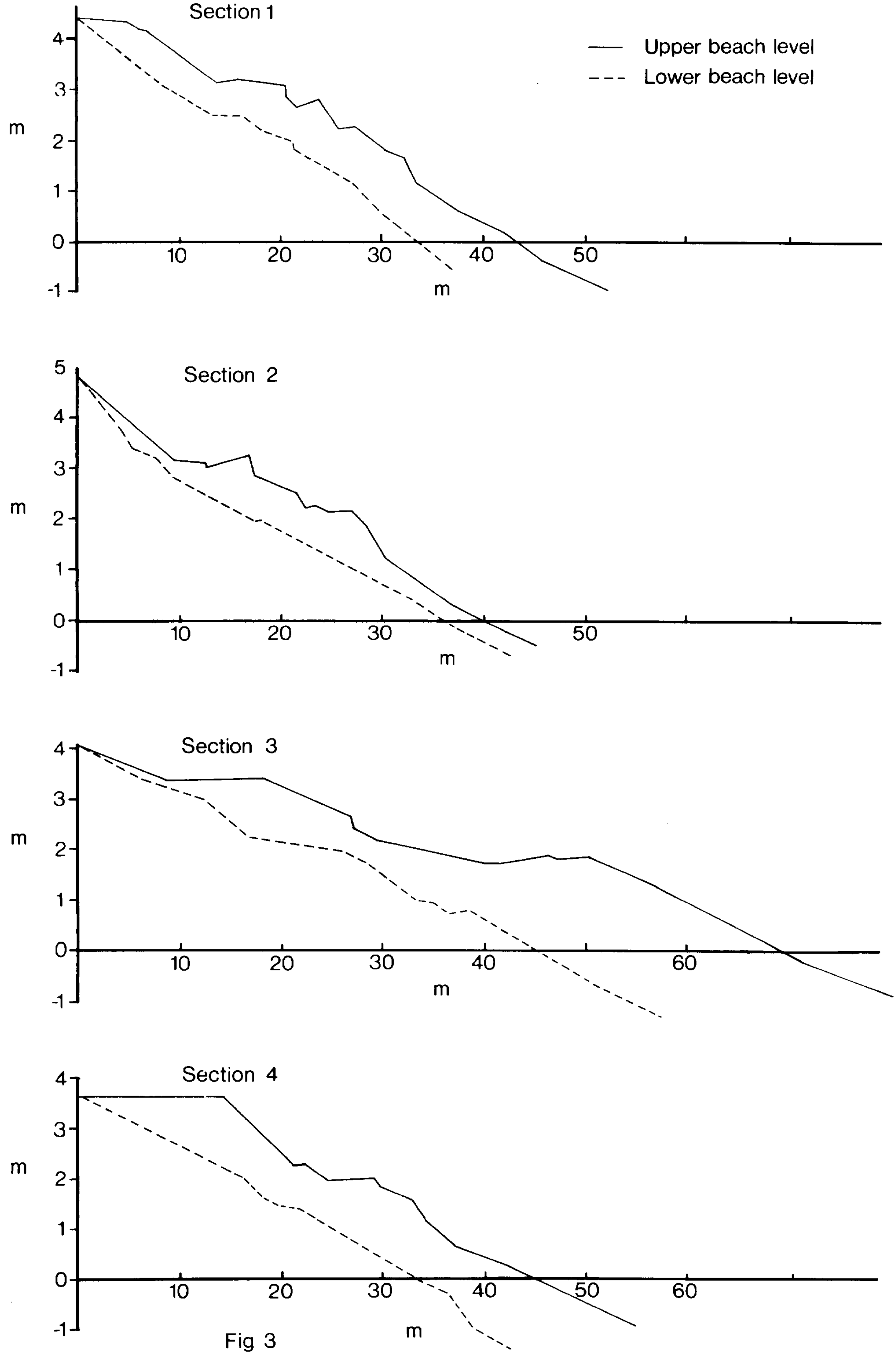


Fig 3

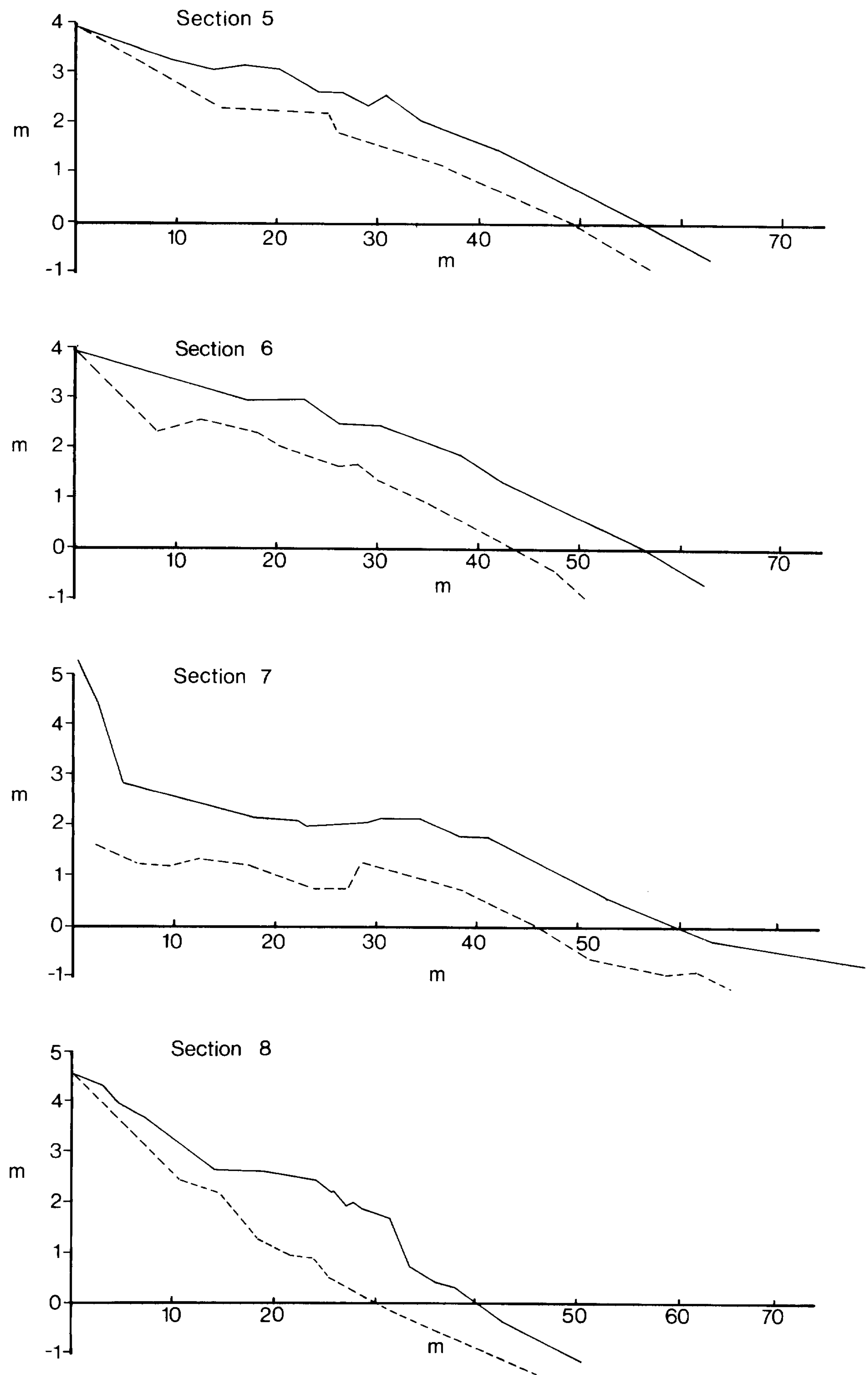

Section 5
Section 6
Section 7
Section 8
m
4
3
2
1
0
-1
5
10
20
30
40
50
60
70

Fig 3

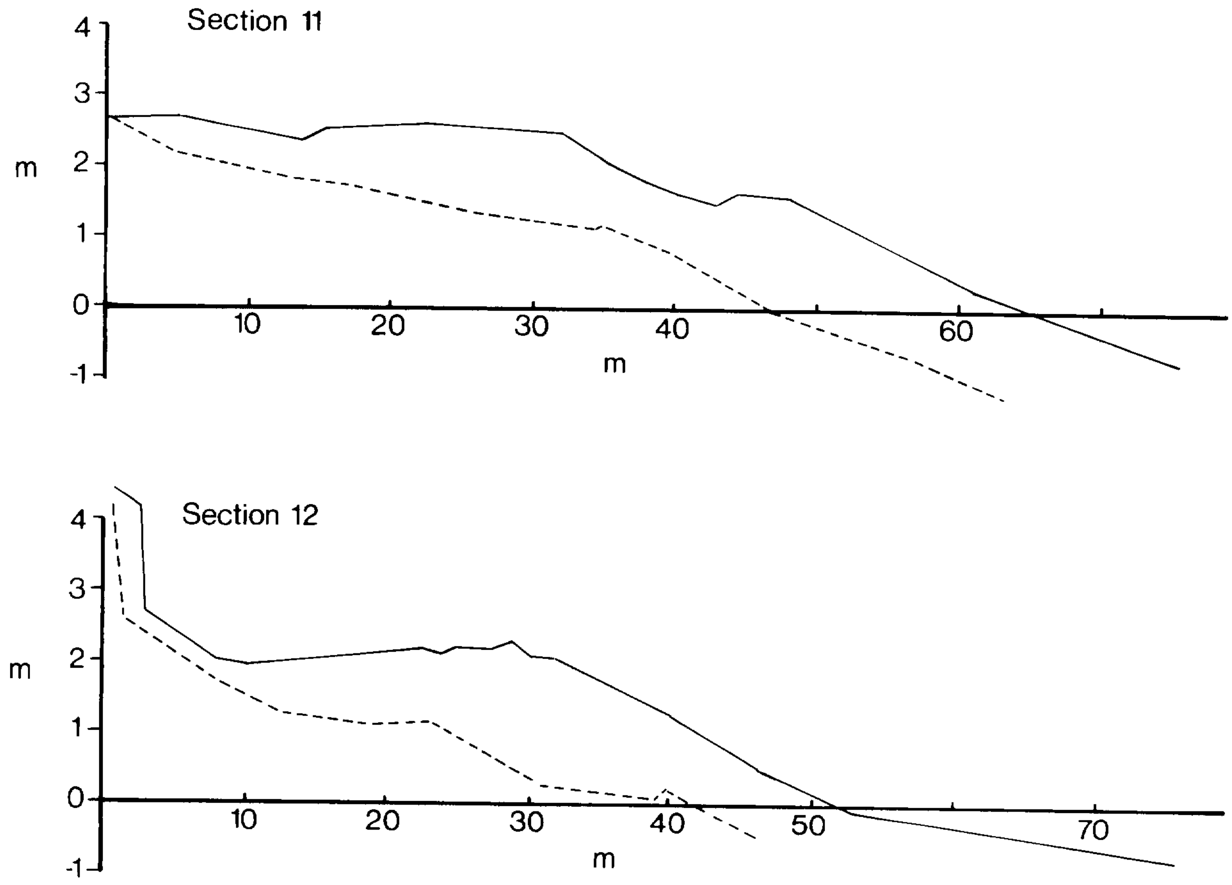

Section 11
4
3
2
1
0
-1
m
10
20
30
40
60
m
Section 12
4
3
2
1
0
-1
m
10
20
30
40
50
70
m

Fig 3

Volumes (m^3) of accretion and erosion and resultant volumes for all sections between successive surveys
March 1978 – May 1979

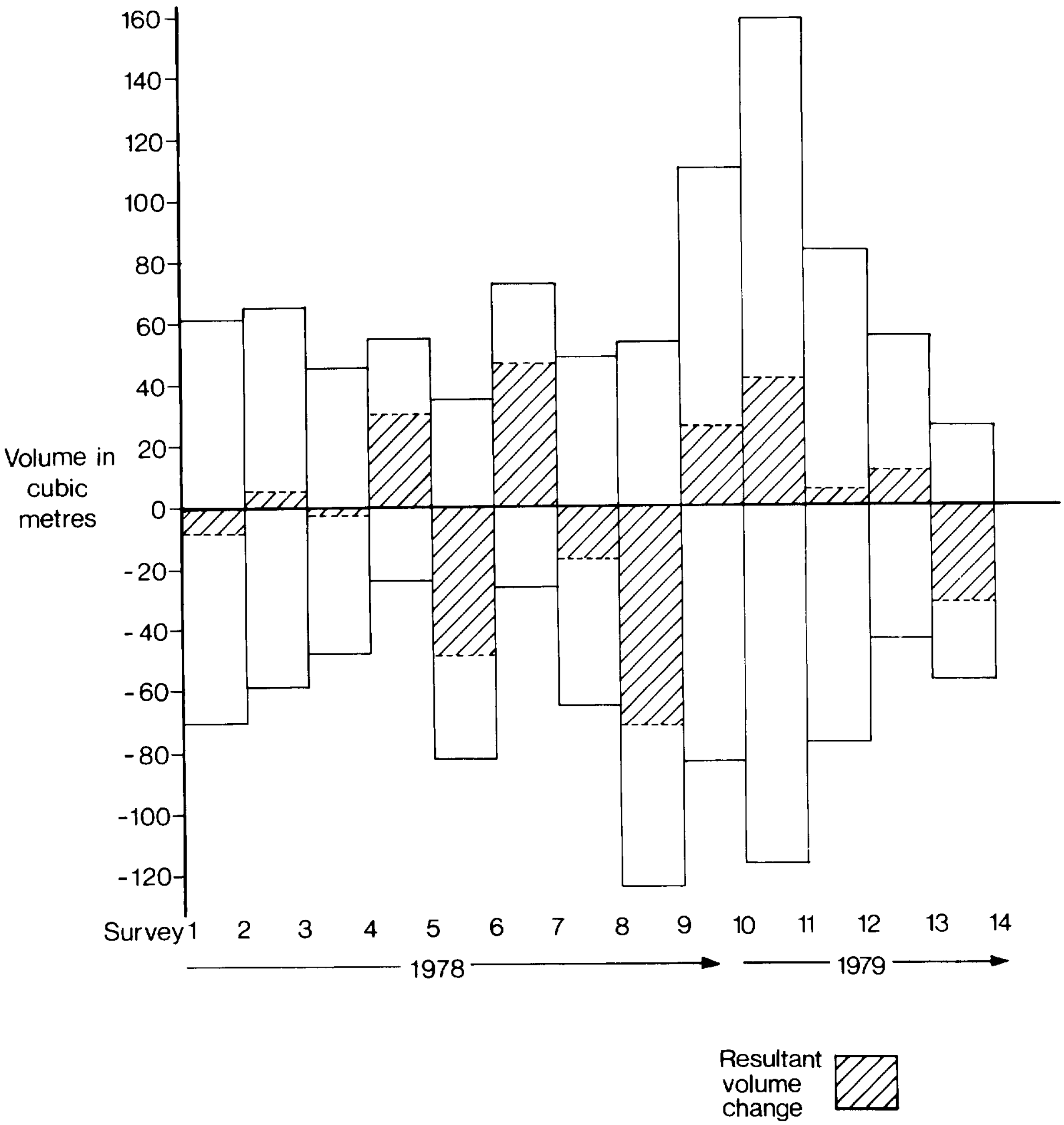


Fig 4a

The Cumulative volume change (m^3) for all sections during the period March 1978 — May 1979

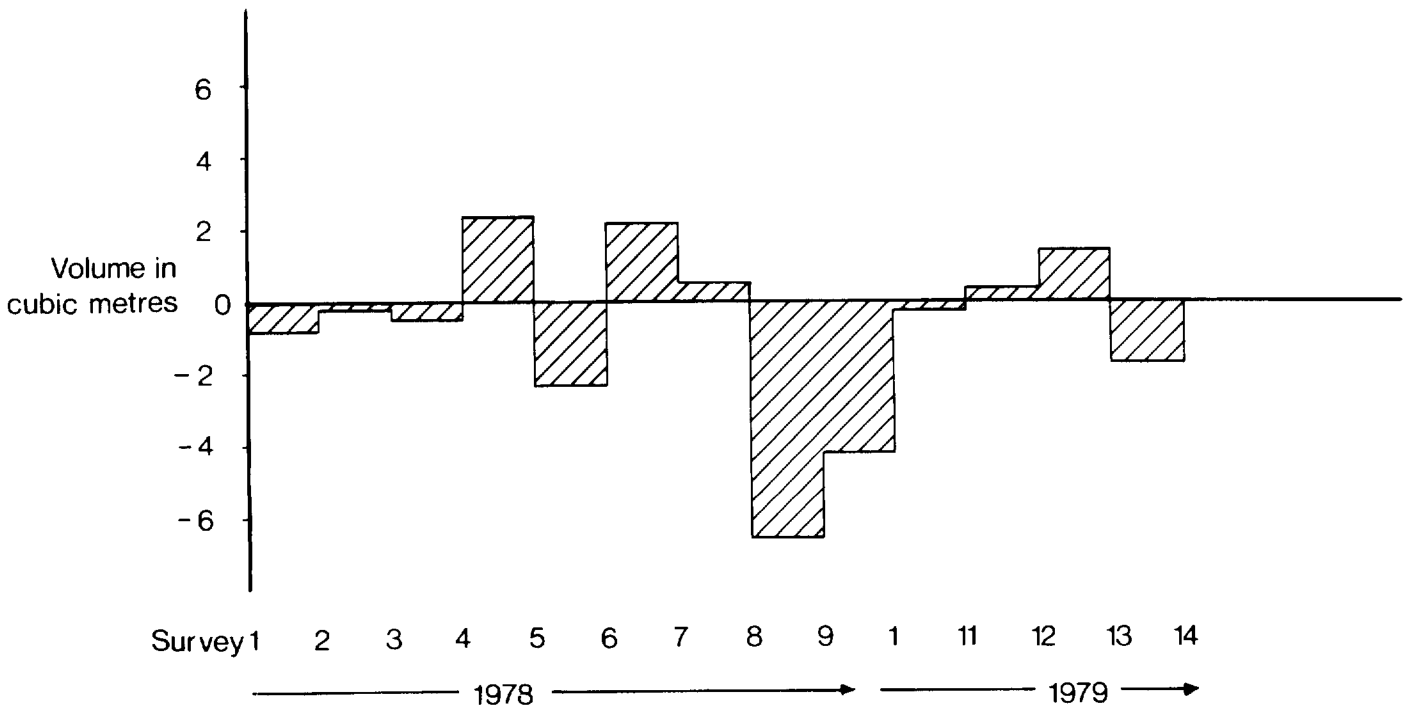


Fig 4b

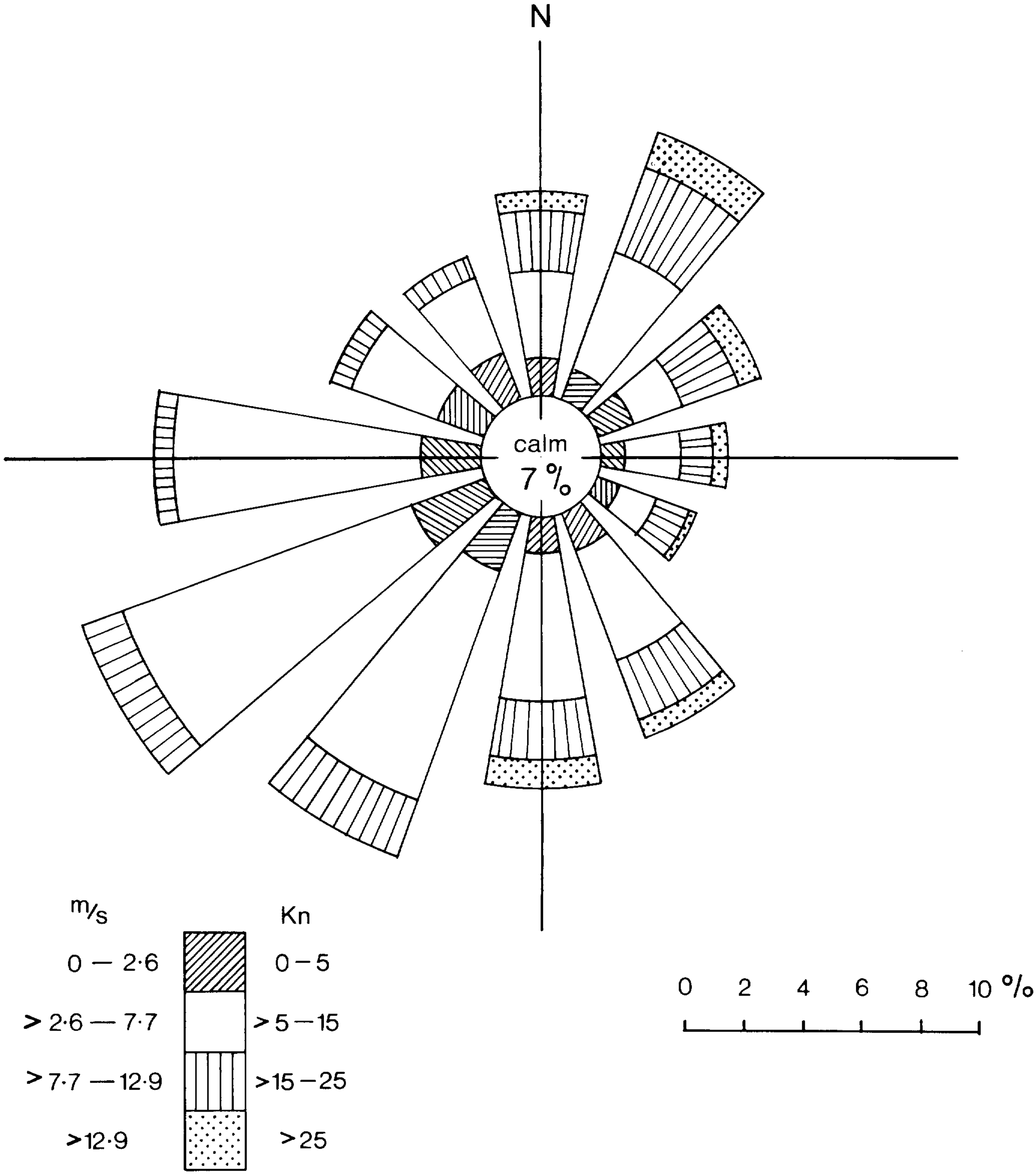


Fig 5

Wind rose showing offshore wind pattern for the period 21 June–19 July 1978 when the least volume change of material was measured

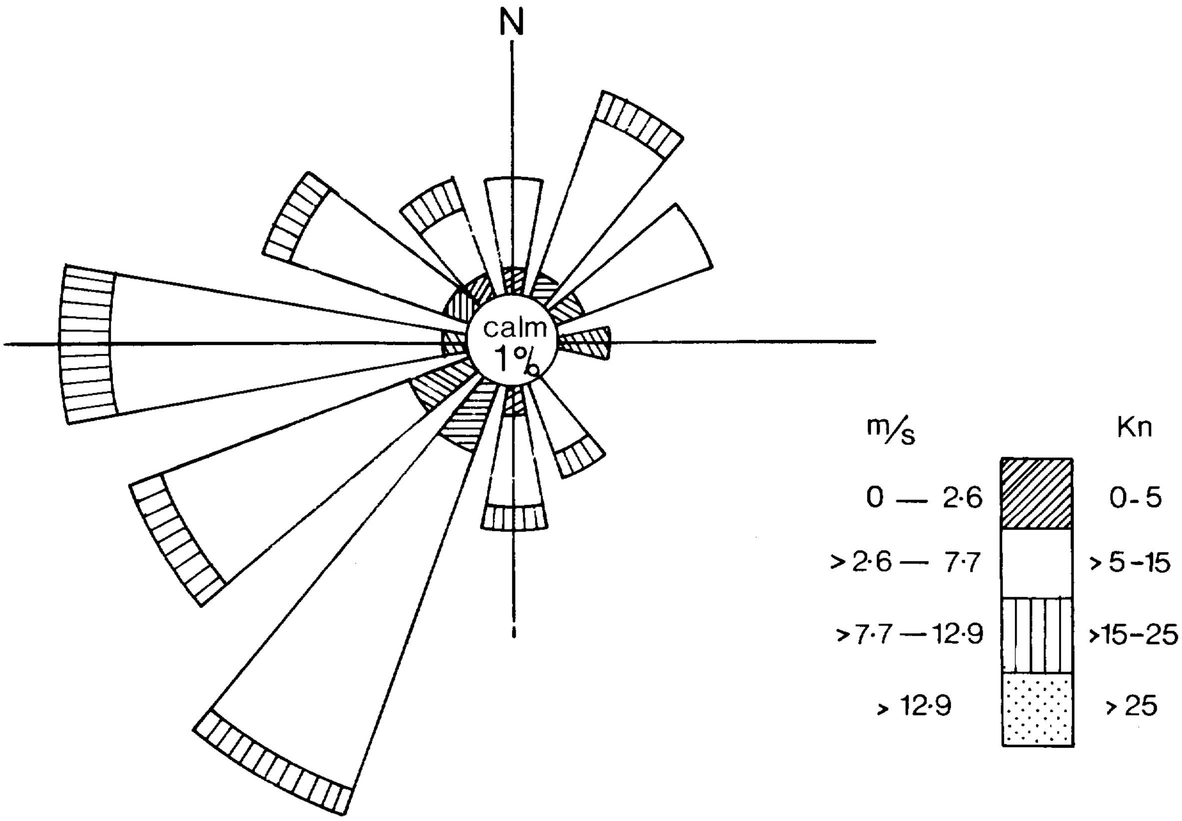


Fig 6a

Wind rose showing onshore wind pattern for the period 27 January–27 February 1979 when the maximum volume change of material was measured

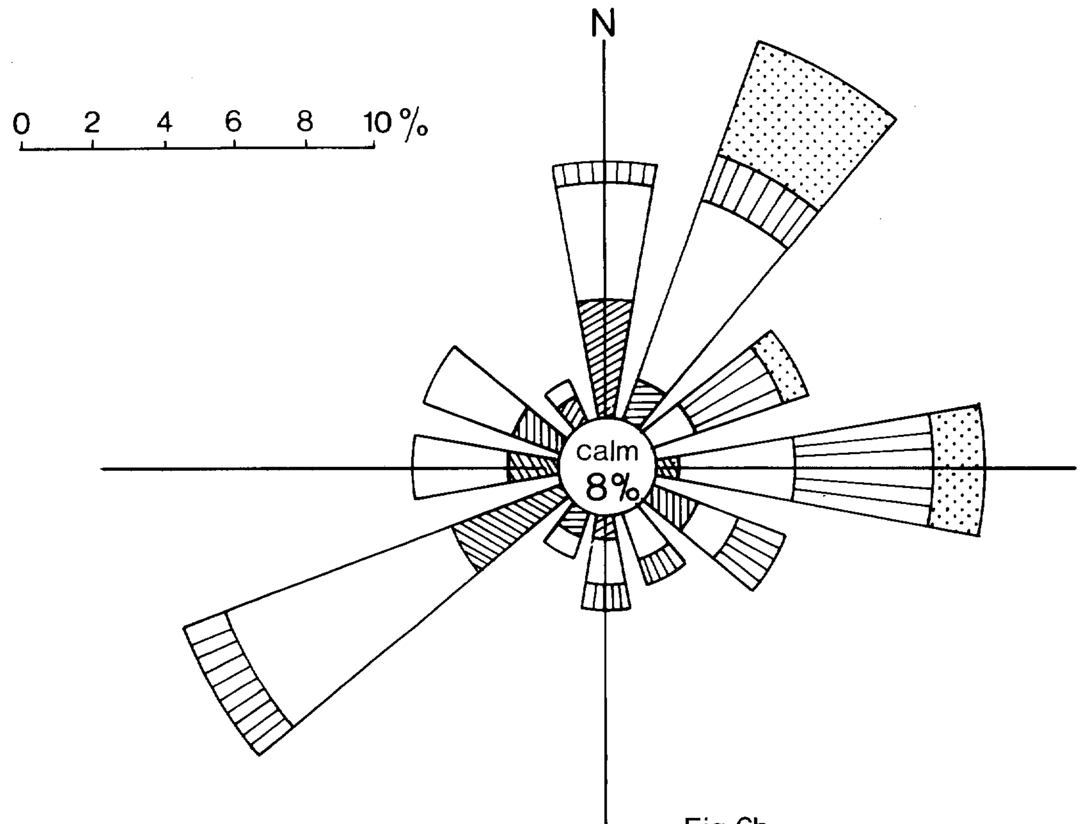


Fig 6b

The total volume of material (m³) moved on the 10 sections between successive surveys March 1978 – May 1979 compared with the corresponding mean Hs (m) value.

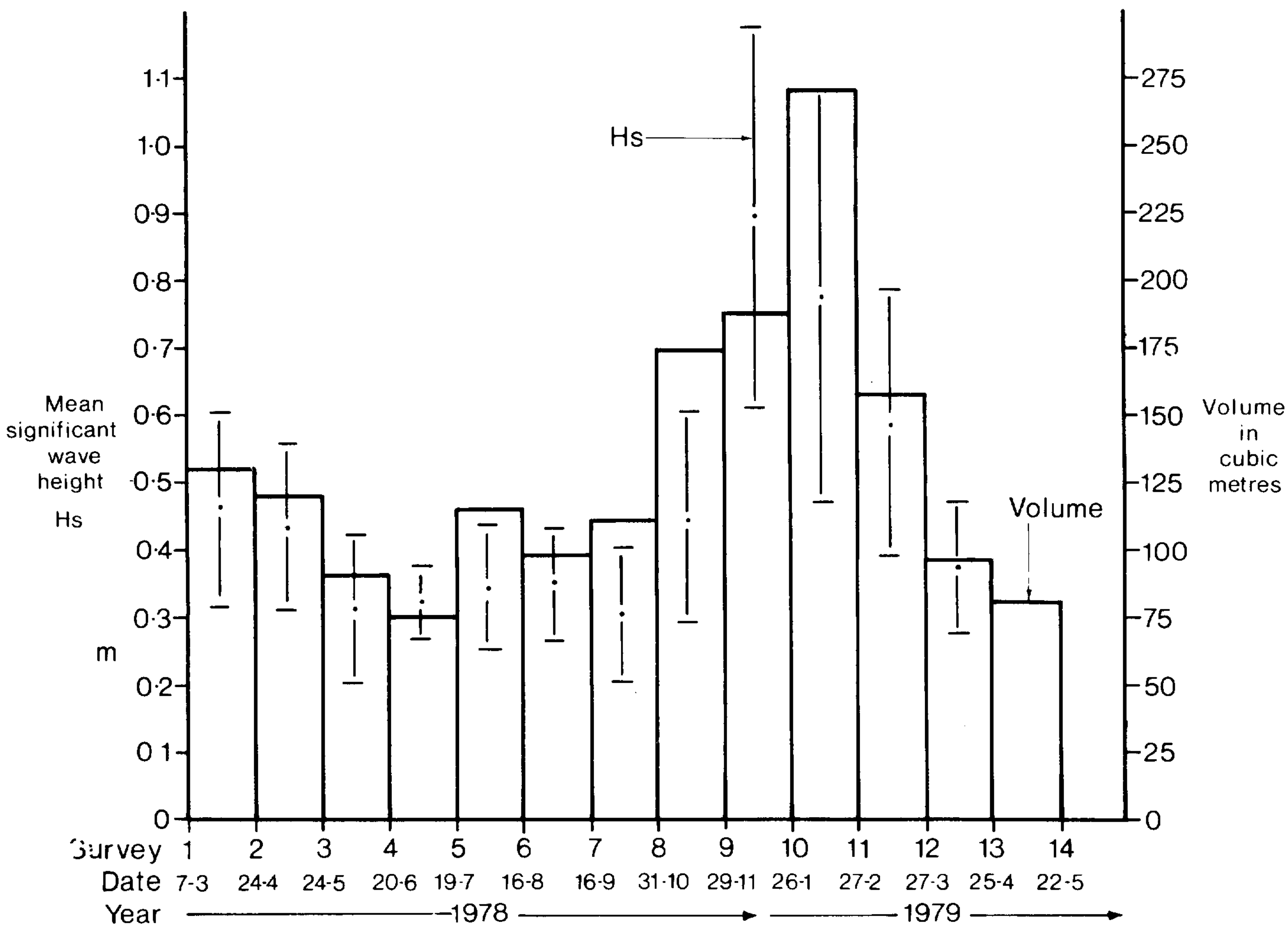


Fig. 7a

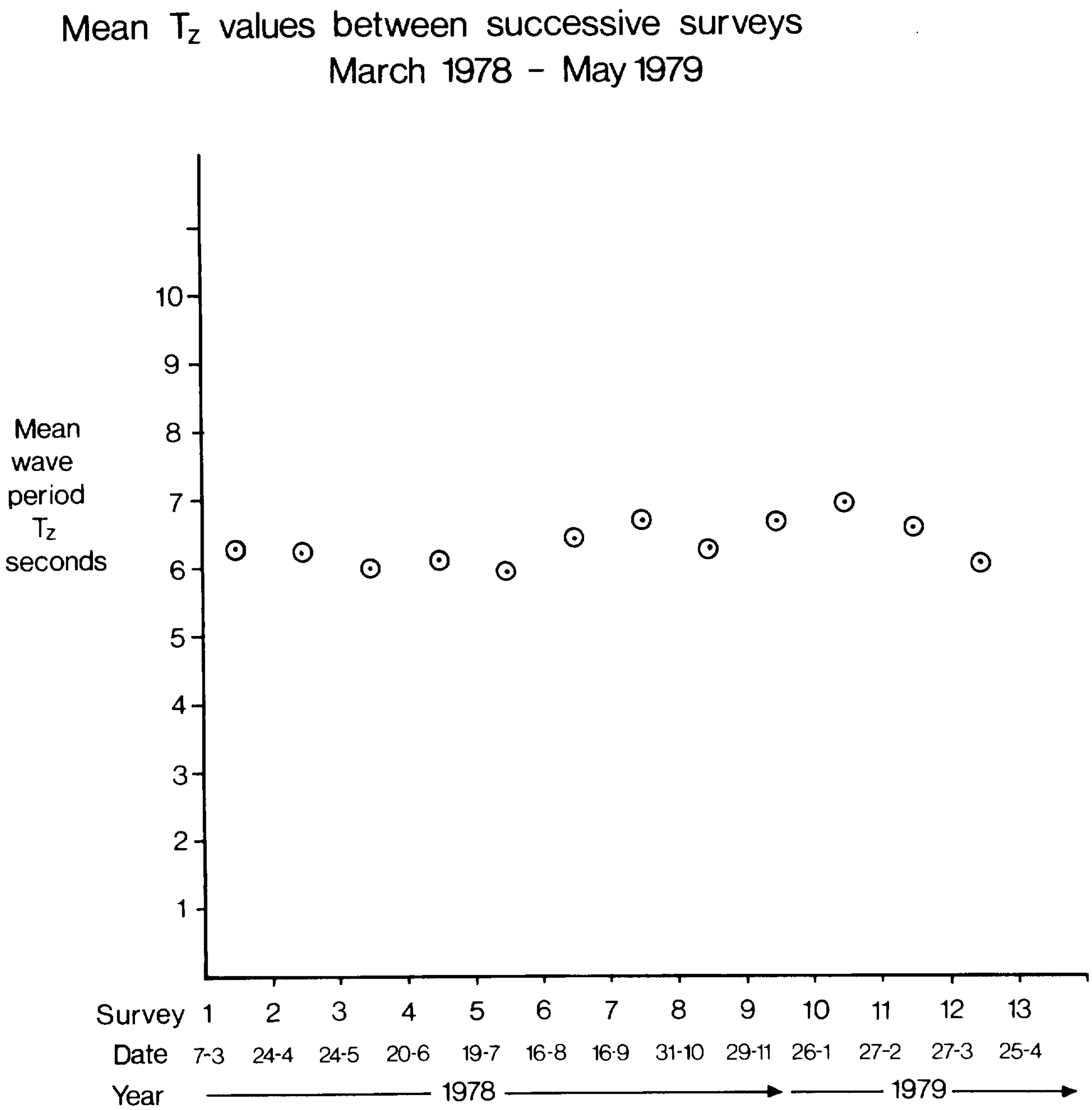

Mean Tz values between successive surveys
March 1978 - May 1979
Mean wave period Tz seconds
10
9
8
7
6
5
4
3
2
1
Survey 1 2 3 4 5 6 7 8 9 10 11 12 13
Date 7-3 24-4 24-5 20-6 19-7 16-8 16-9 31-10 29-11 26-1 27-2 27-3 25-4
Year 1978 1979

Fig 7b