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MEASUREMENTS OF THE HEADLINE HEIGHTS OF GILL NETS IN TIDAL FLOWS

by

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SUMMARY

The use of self-recording manometers to measure gill net height in the sea is described. Records of height variation over tidal cycles are given and correlated with water current measurements. Large changes in headline height were observed.

INTRODUCTION

Bottom set gill nets are known to be affected by tides (Millner, 1985). Dynamic water pressure can force the netting down on to the bottom where it is in danger of snagging. Nets set across the flow are particularly vulnerable and to reduce the hazard, bottom nets are usually set parallel to the flow. In some areas, spring tide flow rates are so high that bottom gill netting is not possible without serious risk of gear loss or damage. Fish behaviour is also related to tide and it is commonly thought that some species are active only at slack water.

Stewart and Ferro (1985) studied the performance of short gill nets in a flume tank. It was found that flow rates of 0.25 m/s or more could significantly reduce net height. Nets set across the flow were more affected than those set parallel to the flow. Nets with a range of mesh and twine sizes were studied and net drag and height measured as functions of water speed. Equations were derived expressing net drag and height in terms of water speed, twine area, netting solidity and buoyancy. The next step in this investigation was to study full size nets in the sea. In the UK, bottom set nets are generally 60 to 100 m in length and used in fleets of 3 or 4 by smaller vessels and up to 20 by larger vessels. The heights range from 2 to 4 m. It was thought that nets of these dimensions, set parallel to the flow, would experience substantial total drag forces and be drastically reduced in height at the upstream end.

A set of self-recording manometers was constructed to measure net height. In this report, the use of these instruments is described and measurements are presented showing height variation over several tides. Where possible, water speed was also measured and the variation compared with the manometer readings.

MATERIALS AND METHODS

Gill Nets

A set of four identical monofilament nylon nets was used throughout these trials. The measured inside mesh size was 151 mm and the twine thickness was 0.57 mm. The nets were slackly hung with hanging ratios of 0.37 on the headline and 0.41 on the footrope. The set length of each net was 55 m. The nets were 22.5 meshes deep and the set height was 3.2 m. The netting was mounted with staple lines on a 7 mm braided polypropylene headrope and a reinforced leadline (128 g/m). 150/30 ring floats were rigged on the headrope at 6 m intervals. Twin 10 m bridles were used, attached by a 10 m line to 10 kg anchors.

Instruments

In Figure 1, the mounting and essential features of the manometers are shown. A differential pressure transducer was used to compare pressures at the headline and solerope. Pressure at the headline was sensed by a rubber air bag contained in a light-weight protective plastic case. This was linked to the transducer in the lower housing by a thick-walled plastic tube containing a smaller, tightly fitting tube of 0.9 mm internal diameter. Including the clearance between the pipes, the air volume was calculated to be 0.9 cm^3/m. The air bag was inflated to atmospheric pressure on the surface and acted as a reservoir to compensate for the increase in ambient pressure at depth. Both housings were attached to the ropes with twine lashings. Data was recorded in solid-state memories of the standard Marine Laboratory type (Mitchell, 1981). The logger sampled the transducer output 256 times per minute and recorded the mean. The manometers were calibrated by attaching a water column of known height to the high pressure input port of the transducer, with the low pressure port at atmospheric.

Tidal speed was measured with a self-recording Braystoke current meter (Series 1000). This is a large instrument and is deployed on a supporting framework. The log was positioned 1 m off the bottom. The current meter reading was sampled and logged once every 10 mins.

Procedure

The manometers were used on gill nets on several occasions on both the east and west coasts of Scotland. The nets were shot along or across the tide, either as two fleets of two nets or as one long fleet of three or four nets. Prior to shooting, the manometers were attached and switched on. They were usually placed at the bridle ends of the nets but, on longer fleets, were also placed between nets. The nets were left in the water overnight, usually for more than 20 hours, then hauled and the instruments read. After clearing and flaking out the nets were reshot. At times the working depth was less than 20 m and it was possible for divers to inspect the instruments in place.

RESULTS

Diver Observations

When inspected by divers, the manometers were found on every occasion to be deployed correctly with the plastic tube not tangled and the net at full height.

Immediately after shooting, the bridles were always found to be slack and floating upwards. On smooth bottom, it was observed that the tide tended to move the nets downstream and gradually pulled the upstream bridles tight. Bottom friction appeared to hinder the drift of the nets.

Headrope Height Measurements

Many measurements of headrope height variation were obtained. A selection of the data is presented in Figures 2 to 6 which illustrates the dependence of headrope height on tidal speed. (On the figures the set numbers refer to the sequence of fleets shot at each site and the unit numbers to the manometers.) Figure 2 contains data from a west coast site with a weak bottom tide, peaking at around 0.15 m/s, although the surface tide was much stronger. No continuous speed log measurements are available for the same period. Figures 3 to 6 contain data from an east coast site where stronger tides were encountered. Each of Figures 3 to 6 includes speed log data on the amplitude and direction of the tidal flow. The arrows indicate the compass direction of flow, vertical meaning north. The log data were collected at a later date and were matched to the gill net height records. This was done by selecting the 24 hour periods during which the times and heights of high and low water most nearly coincided. These times are slightly different and the log data are plotted with reference to the times of high and low water for the net height measuremnts. In every case the set height of the nets was 3.2 m.

In Figure 2, two of the traces have maximum values close to 3 m and the other is close to 2 m. The traces have dips which correspond to the flood tide periods but the dips in the three traces correspond only around 05.00. There are short term fluctuations in net height on each trace, sometimes exceeding 0.5 m.

In Figures 3 and 4, net height is given for fleets of two nets set along and across the tide. Units one and three on Figure 3 and unit three in Figure 4 are suspected of reading low. Where the top of a peak if flattened it is probable that a net has reached its full height. The structure of the traces is quite complex, with all showing large changes in height related to tidal flow rate and also significant short term changes. The correlation with tidal speed is better in Figure 3 than 4. The nets set across the tide might have been expected to show greater height changes than those along the tide. Fleets in both positions undergo large changes in height but there is some indication in the figures that the fleets across the flow spent less time at full height than those along the flow. The peaks in the former case seem to be sharper. When the tide is changing direction there is a period when flow is neither parallel nor perpendicular to the nets and this further complicates comparison.

In Figures 5 and 6 records are presented for longer fleets of nets, along and across the tide respectively. In both figures the changes in net height correlate well with the tidal speed, except immediately after the nets were shot when the nets are well down in height but tidal speed is shown as low. The difference between the two cases is more apparent than in Figures 3 and 4, the peaks in net height in Figure 6 being very sharp compared with those of Figure 5.

DISCUSSION

This investigation has demonstrated that bottom set gill nets are seriously affected by tides. Nets can be significantly reduced in height and during spring tides can reach full height for only short periods. Improved performance might be obtained from nets of lower drag which were less easily flattened by water pressure. During design, every effort should be made to reduce the bulk of the twine, ropes and floats in a net, consistent with preserving essential strength for retaining fish and for hauling. Some improvement might also be gained by placing larger floats (say 12.5 cm diameter) at intervals along a net, provided the extra local buoyancy was opposed by a weight on the solerope.

The data obtained on tidal speeds are not well enough correlated with the net height measurements to enable comparisons to be made with the earlier flume tank observations. Further work is needed to obtain a series of synoptic net height and water speed measurements. The sudden changes in net height noted on several of the traces may be due to bottom friction. As water speed increases, the static friction force will be greater than the net drag and prevent net movement. A stage will be reached however, when the net drag is greater and the net will then move rapidly until restrained by the bridles.

The speed log data used to interpret the net height measurements were collected at a later date and are therefore of limited value. Tidal regimes contain periodic cycles other than the fundamental which ensures that exact repetition of conditions is rare. Thus although the second set of measurements were made on dates with very similar conditions, the detailed aspects of the tidal cycles were inevitably different and only the major changes in net height can be related to the measured flow rates. The short term fluctuations in net height may be due to turbulence in the tidal flow, commonly found in inshore areas. Some of the very rapid large changes in net height recorded may have been caused by interference with the nets. For example, the height changes around 06.00 in Figure 6 may have been due to a trawl overrunning one end of the fleet. If this end was pulled towards the other nets, it could have been flattened and the removal of tension on the rest of the fleet would have allowed these nets to rise. A similar event occurred earlier at this site, leaving a fleet tangled but undamaged.

REFERENCES

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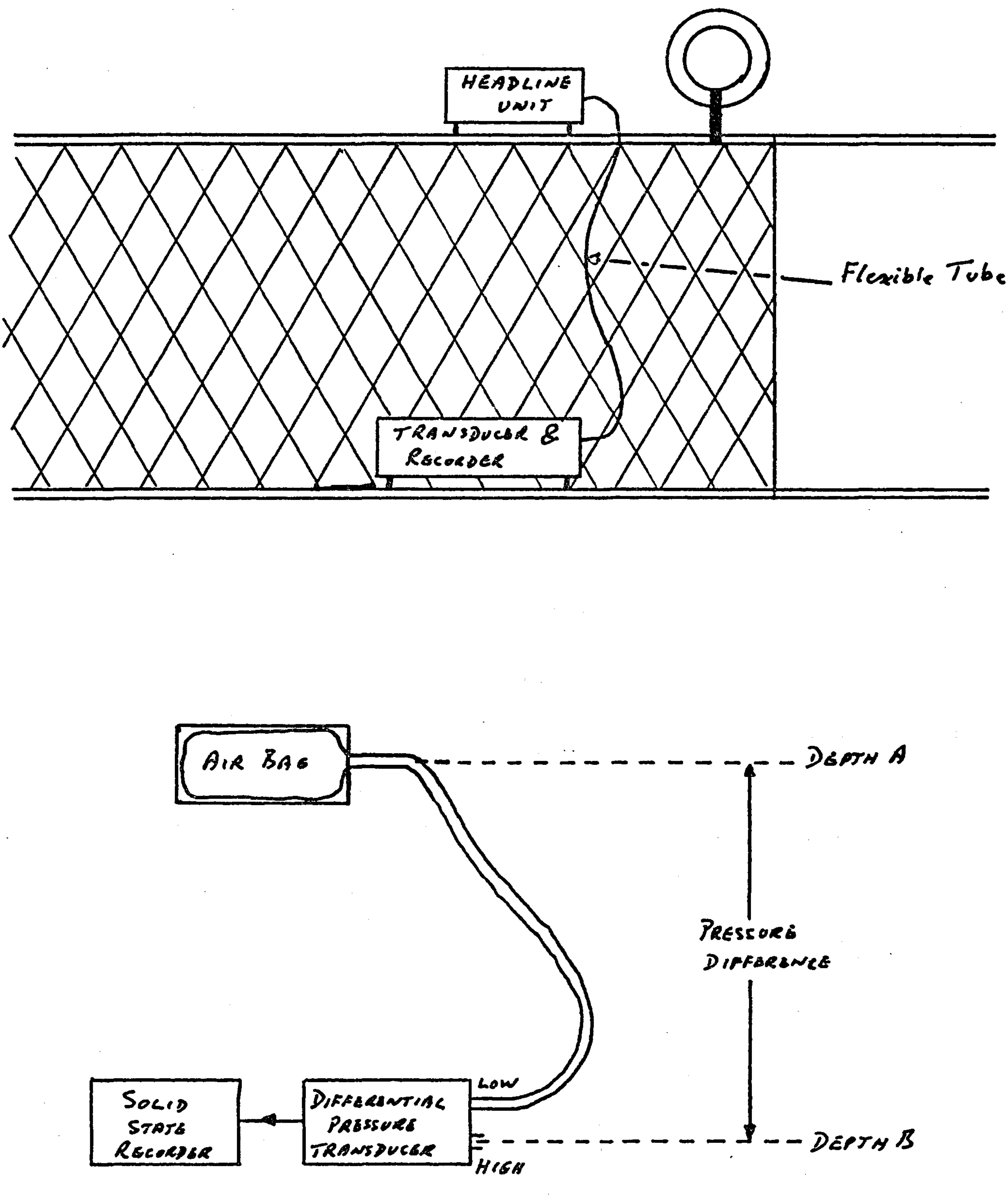

Figure 1 Rigging of manometers on gill nets to measure headrope height.

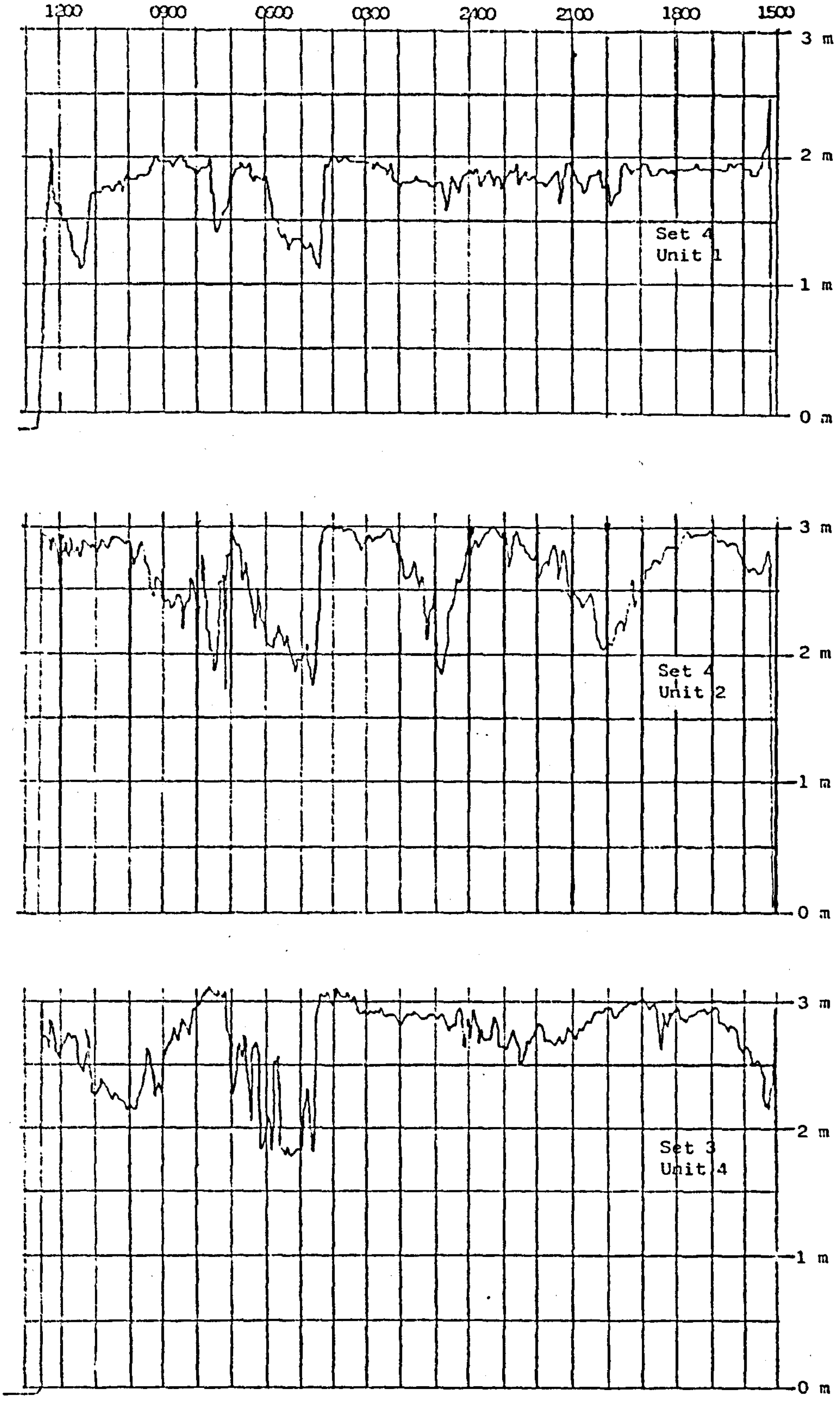

Figure 2 Headrope height variation at the bridles of fleets of two nets set parallel to a weak tide (29 7 84).

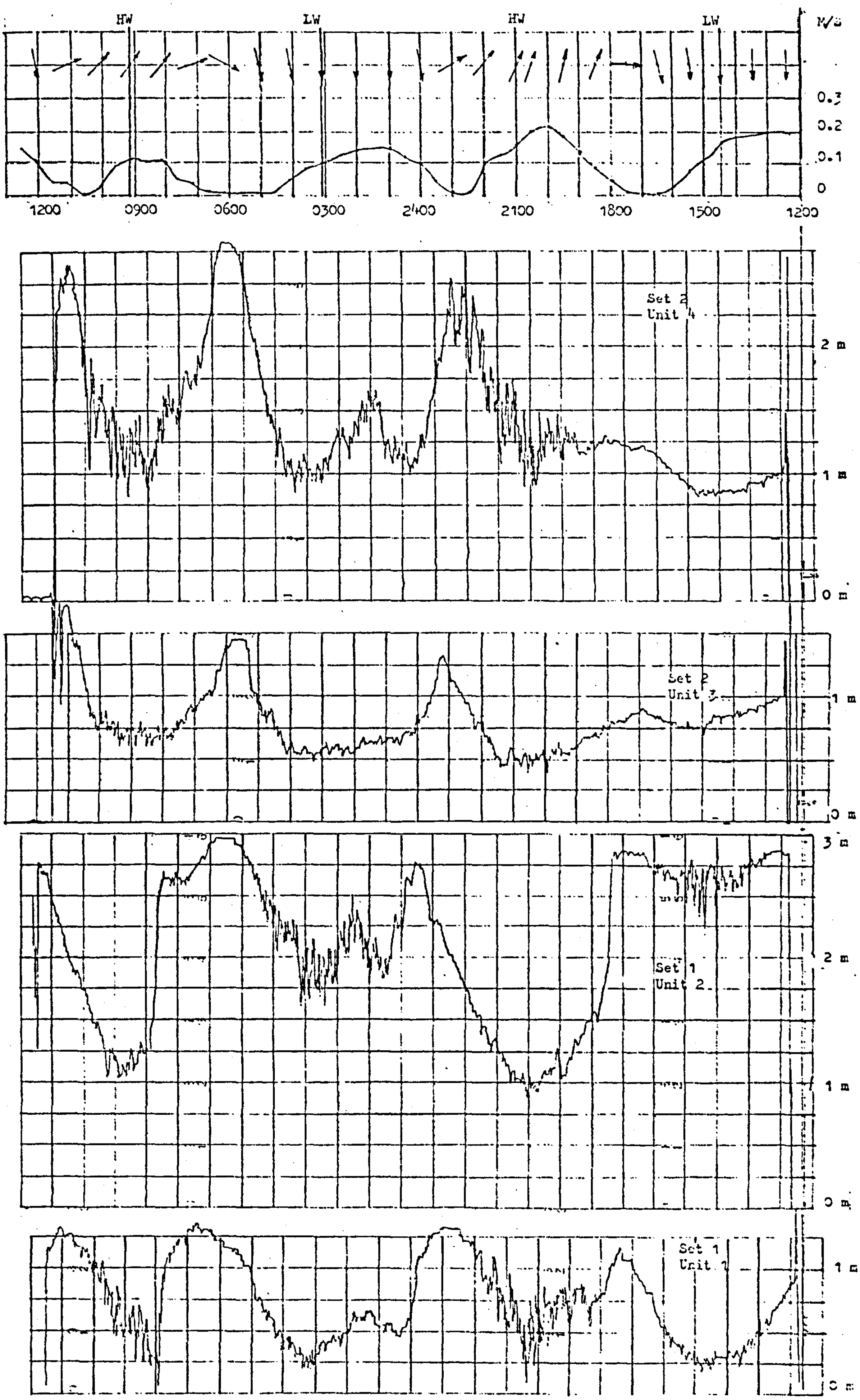

Figure 3 Headrope height variation at the bridles of fleets of two nets set (1) parallel and (2) perpendicular to a strong tide (29 4 85).

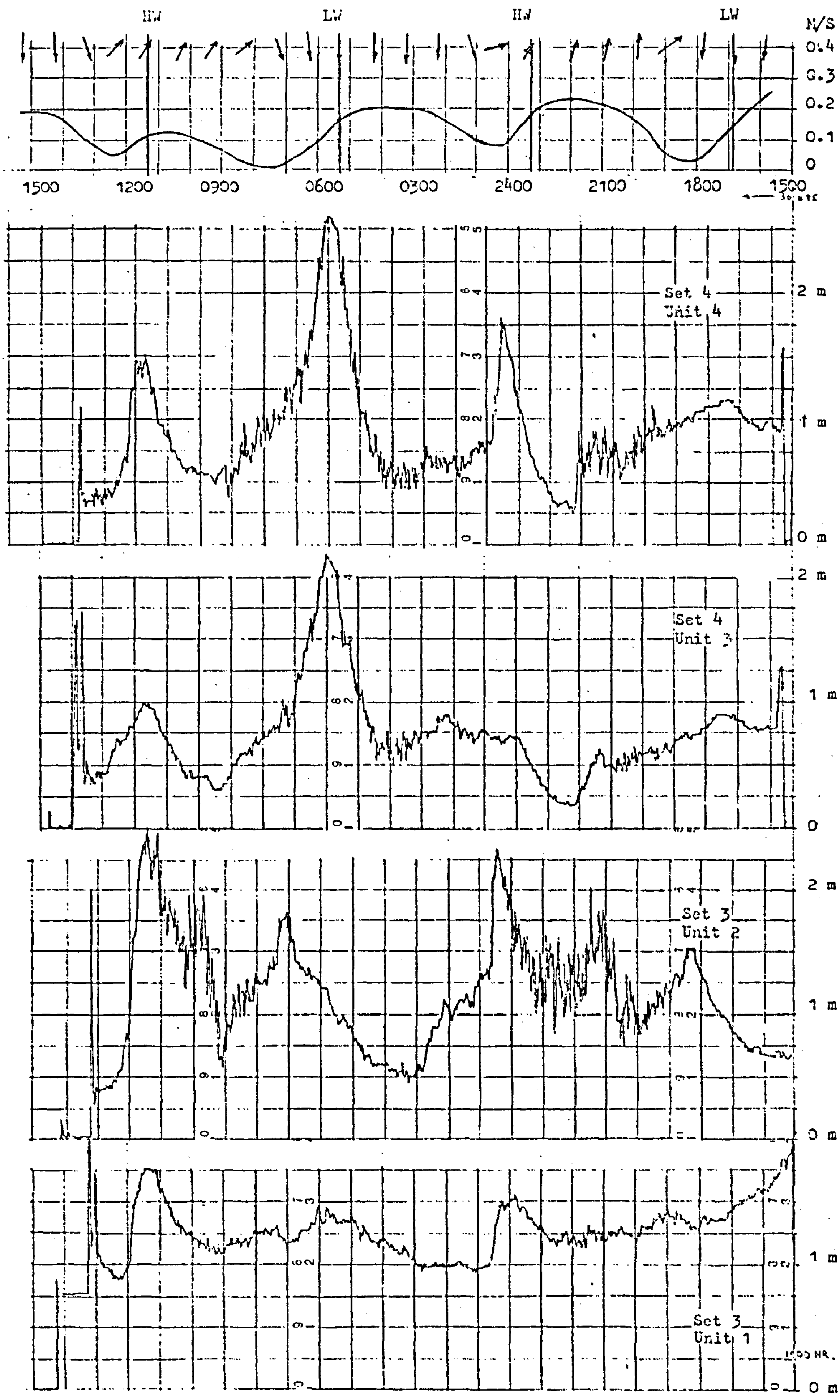

Figure 4 Headrope height variation at the bridles of fleets of two nets set (3) parallel and (4) perpendicular to a strong tide (30 4 85).

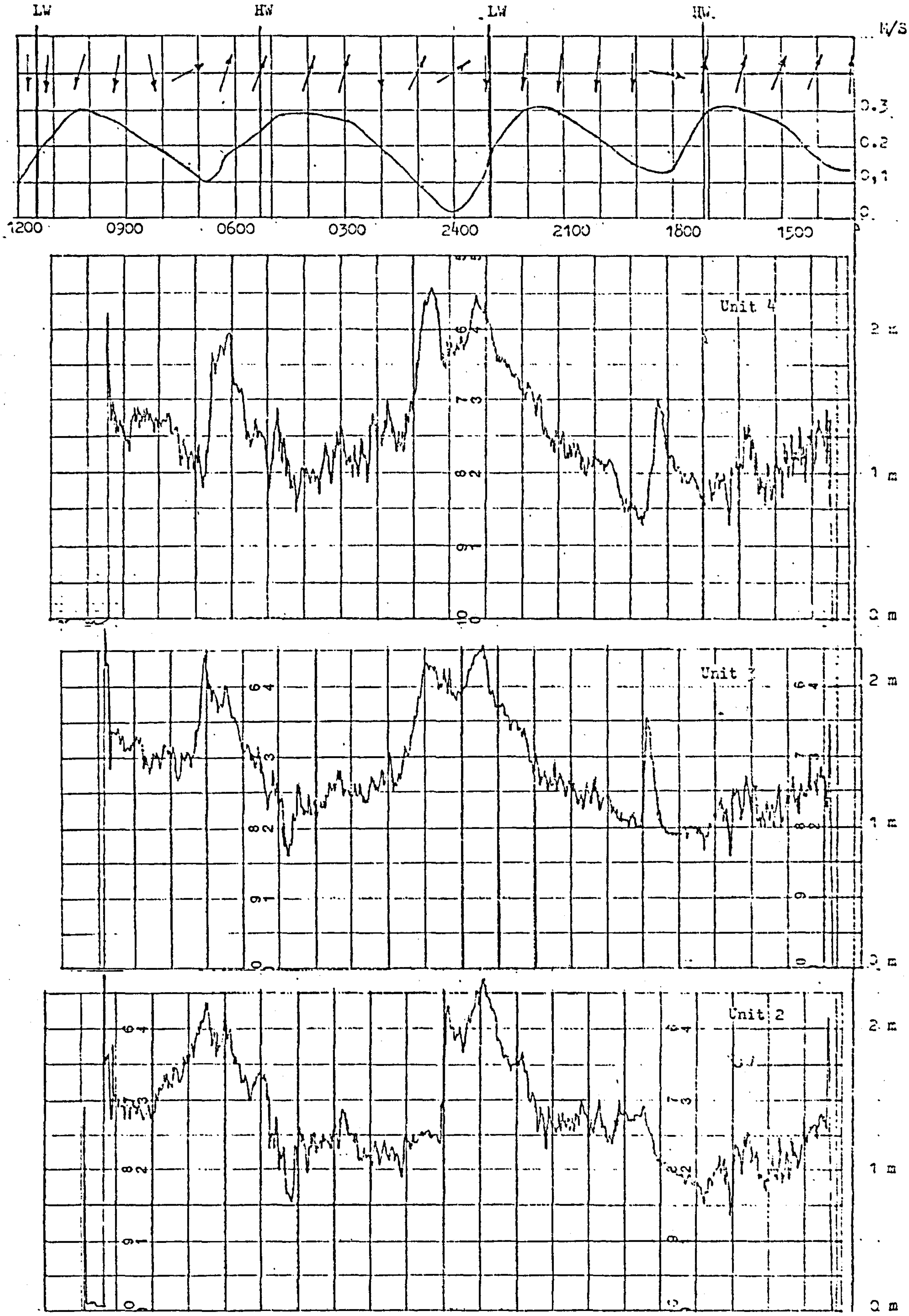

Figure 5 Headrope height variation between nets in a fleet of four nets set parallel to a strong tide (8 5 85).

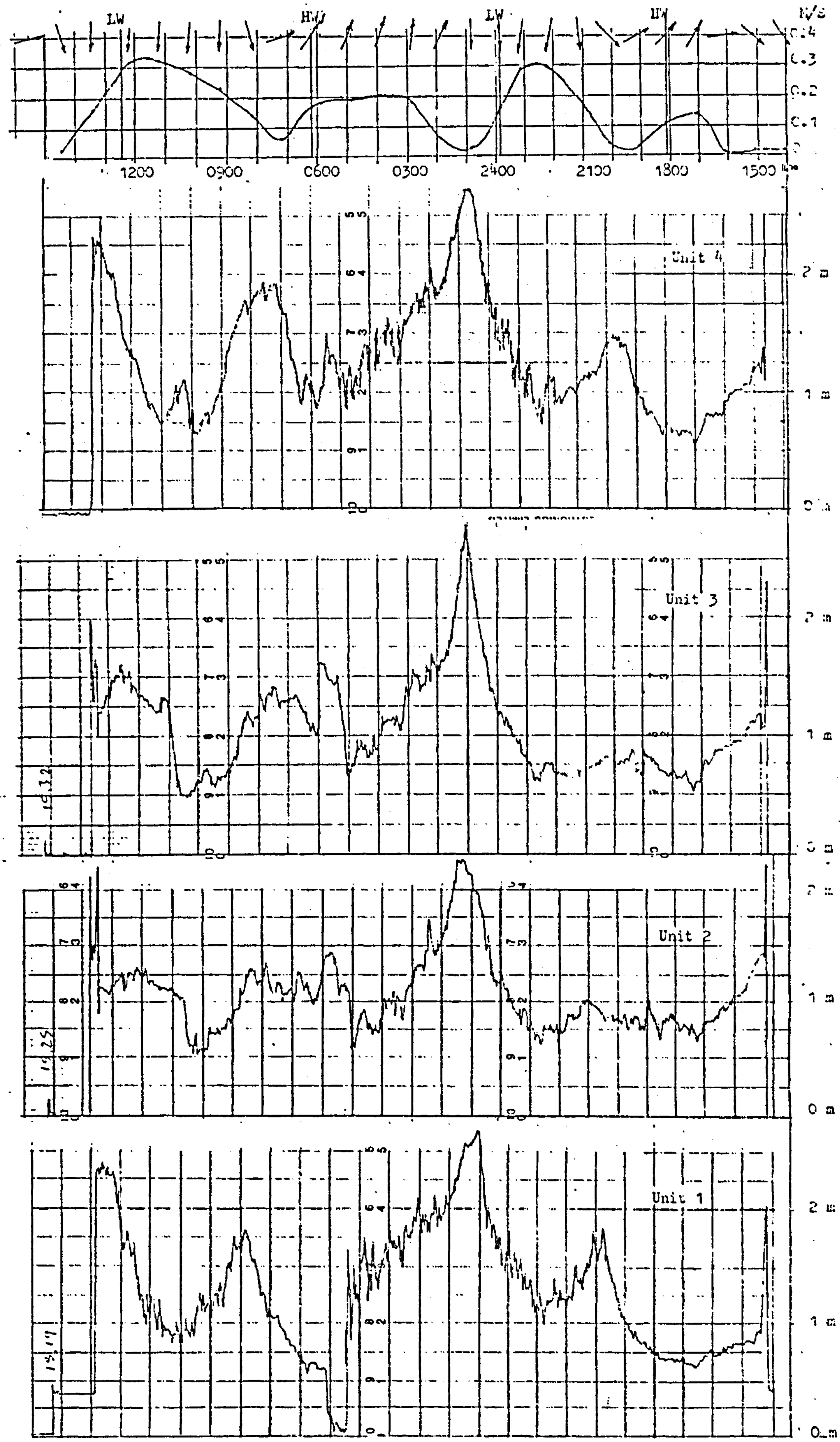

Figure 6 Headrope height variation at the bridles (1) and between nets (2, 3, 4) in a fleet of four nets set perpendicular to a strong tide (9 5 85).