7 Waves on Steady Currents

The previous chapter described how changes in the speed of a tidal stream make the sea rougher or smoother. Tidal streams that flow at constant speed cause comparable effects but do so by bending the wave trains, rather than by compressing or stopping them. This phenomenon is a form of wave refraction – not to be confused with the other kind of wave refraction that is caused by changes in depth, and which was described in Chapter 4. It usually happens where a fast current flows past an area of still or slow-moving water.

To illustrate the process diagrammatically, in Fig 7.1 waves are rolling upstream against a current while also crossing the current obliquely, at an acute angle. The waves are moving towards a shear line between the current and an area of still water. Close to the shear line, the current is weaker. As each wave approaches the shear line and enters the zone of weaker current, the part of the wave that is nearest to the shear line is able to move upstream more quickly. This has the effect of swinging the wave crest forward and turning the wave back into the current. The wave energy is therefore trapped in the current and the area of the current becomes rougher while the still water becomes calmer.

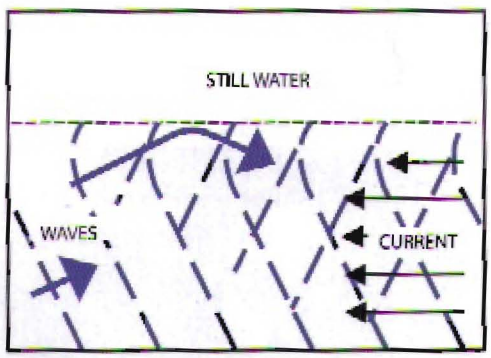

Fig 7.1 Wave refraction at a boundary between an adverse current and still water

At the shear line there is an abrupt change in the roughness of the water and this can also be seen in Photo 7.1. In the middle distance a tidal stream is flowing across the view, from left to right, and is diverging from the coast after passing a headland. Wind-driven waves are rolling upstream, against the tide, from right to left. In the foreground (inshore of the tidal stream and downstream of the headland), there is an area of still water, with a slightly grey, silty appearance that contrasts with the darker tint of the water in the current.

The current is flowing at about 2 knots, against a Force 6 wind, and is covered by breaking wave crests. The still water, on the other hand, has fewer breaking crests, with hardly any close to the shear line at the edge of the current. Even if there were