CHAPTER FOUR

THE SEA.

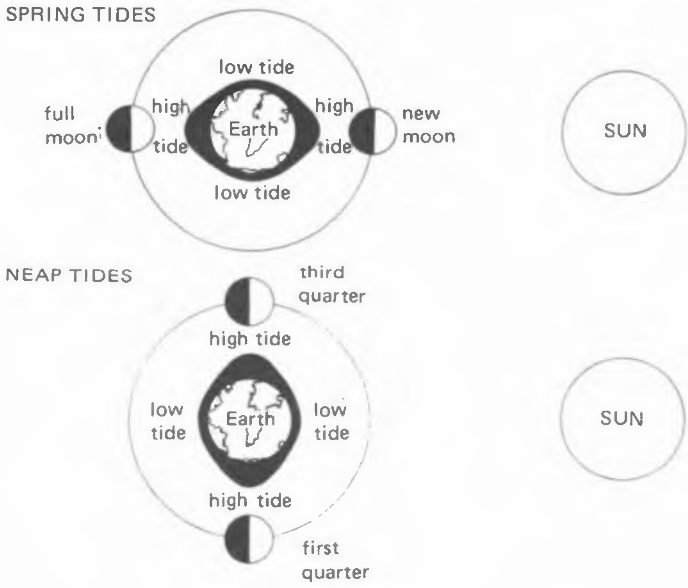
About seven tenths of our planet is covered by water. Mainly this water is sea. The sea is not stationery, but is constantly in motion. The motion is caused by the sun and the moon and by weather. The sun causes thermal currents as well as assisting the moon to cause tides. The weather, particularly the wind, causes waves.

TIDES.

Tides cause a rise and fall in the depth of the water as well as causing strong variable currents or streams. Briefly, the sun and moon exert a pull on the waters of the earth causing a rise in their level in one part of the earth and a consequent fall in another. The moon has a greater effect than the sun because it is much closer to the earth.

The rise and fall of the tide is greatest when the moon and sun are in the same straight line with the earth - either when both are on one side of the earth or each is in opposite sides of the earth. These are known as Spring tides.

Diagram 8

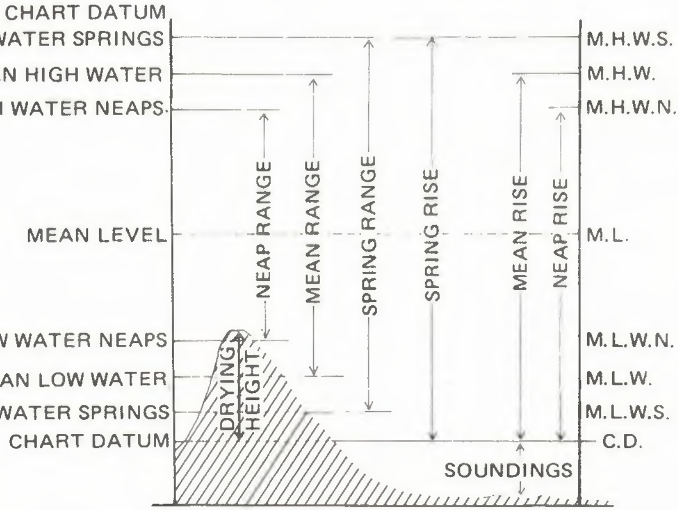


The rise and fall of the tide is least when the moon and sun are at 90° from each other in relation to the earth. These are known as Neap Tides. Put another way, Spring tides occur at times of full and new moon, and neap tides occur at the moons quarters. Because the earth rotates on its own axis and the moon rotates around the earth there are two High waters and two Low waters in one LUNAR DAY which is 24 hrs and 50 mins. This is called a SEMI-DIURNAL Tidal Pattern i.e. in ordinary time, a High Water, followed by a Low water about 6 hrs and 12 mins later, another High Water at 12 hrs 25 mins, a Low water at 18 hrs 37 mins, and the cycle completed by the following day's High Water at 24 hrs 50 mins.

Tidal Streams.

Whereas tides are vertical movements of the water or sea level in response to various gravitational pulls, tidal streams are simply the horizontal movements of the water, occurring in response to the same forces as the vertical movements. So the rise and fall of the tides causes tidal streams. These streams, their directions and rate of flow can be discovered by consulting a tidal streams atlas. The rate of flow of the tidal streams is dependent on whether the tide is making i.e. increasing up to Springs, or taking off, i.e. decreasing towards Neaps. To find the rate of tidal streams at any time use the "THIRDS" rule - 1/3, 2/3, 3/3, 2/3, 1/3 of maximum rate at the time. The stream is at a maximum about half time between the changes of direction and at a minimum at the time of changes of the stream at slack water.

Diagram 9



Tidal Stream Atlases are available from good Chandlers and these show the direction and rate of tidal stream around any selected area.

To find the amount by which the tide will rise or fall in a given time from high water use the "Twelfths" rule.

The first hours rise or fall		=	1/12 of range
2nd "	"	=	2/12 "
3rd "	"	=	3/12 "
4th "	"	=	3/12 "
5th "	"	=	2/12 "
6th "	"	=	1/12 "

The 'Twelfths' rule can really only be applied in the open sea. The rise and fall of the tide in estuaries is often determined by other local factors like the restrictions and constrictions imposed by the coastline and sea bed.

Strong winds are responsible for speeding up or slowing down the times of high or low water when they blow with or against the direction of tidal movement.

The stream is said to be slack at that instant when its direction of travel is reversed. More usually the term is used to refer to the period around the instant of reversal when the stream is a quarter of a knot or less. At most places the tidal streams attain their greatest rate roughly halfway between successive slack waters.

The main anomaly to the above paragraphs is in the open sea where the streams do not oscillate to and fro in a straight line, but travel in an ellipse. There is then no true slack but merely a falling off in rates at the extremities of the ellipse.

Relevant rates of flow are normally quoted on charts at important places e.g. Ramsey Sound "7 kn. Sp. 5 kn. Np." (7 knots, Springs, 5 knots Neaps)

Slack periods vary from place to place according to coastline and the configuration of the sea bed and at different times of the lunar month. It follows that the greater rate attained at springs would result in shorter slack periods and vice versa. For instance on a calm day in Bardsey Sound a slack period on neaps could be anything up to half an hour. Whereas on the other side of Ramsay Island at springs slack is often detectable only as just a different sort of confusion, and one can almost hear the screech of 'tidal-tyres' as it does a handbrake turn and hurtles off in the opposite direction.

Slack water does not always coincide with the time of high or low water. The main reason for this, again, are the restrictions and constrictions imposed by the coast line and sea bottom.

It was sometime around 325 BC that Aristotle wrote "it is even said that the many ebbings and risings of the sea always come with the Moon and upon certain fixed times". What he meant to say was "when planning a sea canoeing trip, do not underestimate the gravity of the situation". ! !

Tidal Constants.

The time of high and low tide and the depth of water are quite often not as actually predicted.

Tide Tables are mathematically correct but environmental factors like wind, high or low atmospheric pressure may speed or slow an incoming or ebbing tide.

The usual system adopted in tide tables is to give times of high and low water and depths at certain PRINCIPAL PORTS, plus tidal constants, or corrections, to be applied to them to obtain the times and depths at other places.

For example if it is required to know the time of high tide on a particular day at say Holy Island, we must first find it for the nearest principal port which is River Tyne (North Shields) - subtract 43 minutes.

The prediction for the principal ports are in turn based on calculated prediction of one STANDARD PORT. In the British Isles the standard port is Dover.

Currents.

To avoid confusion between tidal streams and currents I will briefly explain what currents are.

A current is defined as an onward horizontal movement of water caused by factors other than gravity which causes tides.

Some currents are transient features and affect only a small area such as a beach. These are the oceans' responses to local, often seasonal conditions. Other currents are essentially permanent and involve large parts of the worlds oceans. These currents are the response of the ocean and atmosphere to the flow of energy from the tropics and sub tropics to the sub polar and polar regions.

There are surface currents and deep ocean currents. Surface currents are usually wind driven and deep ocean current are driven by differences in sea water density which in turn is controlled primarily by temperature and salinity variations.

Races.

Races are to be found around headlands, and between islands and are caused by the headland constricting the fast moving tidal streams. A race is fastest and most dangerous during Spring tides and rough weather. They should be avoided as a rule. An example of a tidal race is that found around Portland Bill.

Overfalls.

Overfalls are a disturbed water surface due to vertical currents 'bubbling' to the surface as a result of tidal streams meeting under water obstructions. See Diagram 10.

They can be very aggressive areas of water and are no place for the unwary. It can be similar to a Grade III river only without the hazard of hitting submerged rocks.

WAVES.

The sea surface is rarely still. Waves cross its surface continuously carrying energy. Any disturbance such as a pebble dropped into the water or a submarine landslide can generate a wave. Wind and earth-quakes are the most important wave generators.

It is waves caused by wind that concern the sea canoeist.

Winds cause waves which range from ripples less than a centimetre high to great storm generated waves more than 30 metres high.

To study a wave I will describe a simple group of sea waves (a wave train). Watching a series of such progressive waves pass a fixed point, such as a piling we see a regular succession of crests - the highest part of a wave - and troughs - the lowest part of a wave. The wave height is the vertical distance from the crest to a trough. Successive crests (or troughs) are separated by one wave length. The time required for successive crests (or troughs) to pass our fixed point is the wave period; commonly expressed in seconds. Wave period is easily measured and frequently used to classify waves.

$$\text{WAVE SPEED} = \frac{\text{WAVE LENGTH}}{\text{WAVE PERIOD}}$$

Wave steepness is the ratio of wave height to wave length i.e.

$$\text{WAVE STEEPNESS} = \frac{\text{WAVE HEIGHT}}{\text{WAVE LENGTH}}$$

It is worth noting that a piece of wood floating on the water surface moves forward on each wave crest and backward in the wave trough. After the passage of each complete wave the log returns to its initial position. This demonstrates that only the wave form is moving; there is little net water movement associated with the passage of such a wave in deep water.

Waves are not influenced by the sea bottom where the water depth is greater than half the wave length. Therefore the deep ocean wave speed is determined by the wave length and period, with the longer waves travelling faster than the shorter ones. Long waves from a distant storm arrive first, followed by the shorter waves.

Diagram 10

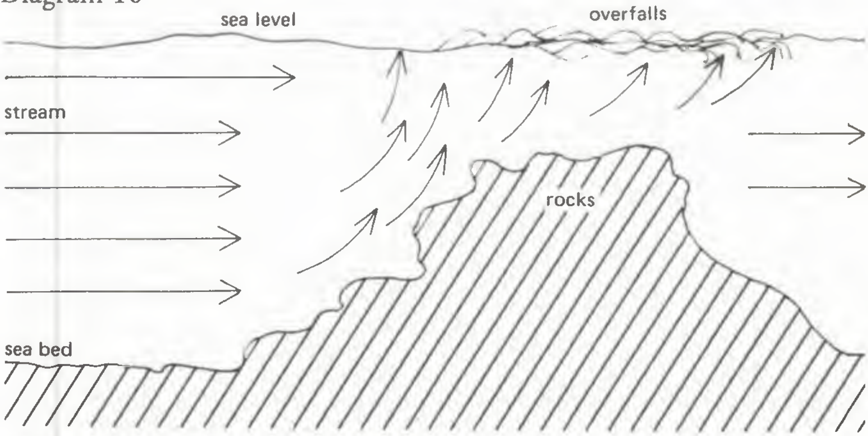
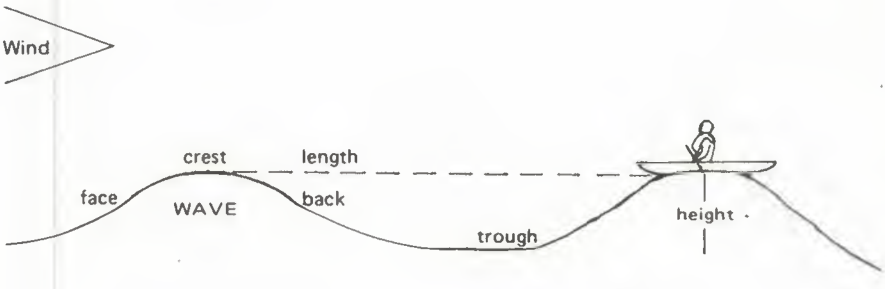


Diagram 11



WINDS & WAVES.

When the wind begins to blow across a still water surface, it first sets up small wavelets or ripples usually less than one centimetre high with rounded crests and V shaped troughs. Because of the small size of ripples, surface tension - resulting from the mutual attraction of water molecules - influences their shape. Ripples, also called capillary waves, move with the wind and last only a short time, but provide much of the wind's 'grip' on the water. They cause both wave formation and wind induced currents.

As wind strength increases, small waves called gravity waves are formed which also travel with the wind. The size of the waves formed depends on the wind speed, the length of time it blows in one direction, and the distance the wind has blown across the water. This distance is commonly known as the fetch.

In short, the size of the waves depends on the amount of energy imparted to the water by the wind.

In a storm or strong wind a complicated mixture of superimposed waves and ripples develops known as a 'sea'. The waves continue to grow until they are as large as a wind of that speed can generate. After the wind dies the waves continue to travel away from the generating area. After leaving the generating area, the waves change, becoming more regular. These long regular waves outside the generating area are known as swell. Much of the energy in ocean waves is transmitted by the sea and the swell. Wind waves may be classified according to their period. Ripples have periods of a fraction of a second. Wind waves in fully developed seas have periods up to fifteen seconds; swell has a period of from five to sixteen seconds. Waves (unlike currents) tend to move in the same direction as the wind that generated them. A wind from a different direction may destroy a pre-existing wave pattern and generate a new one in its place.

A wave may grow too high for its length in which case it's crest overbalances and forms foam called a 'white cap' and wind catches this foam to form a spray known as 'spindrift'. Because the wind varies in force and direction several distinct groups of similar waves (wave-train) may mingle to produce a confused choppy sea.

SURF.

As waves approach the beach and the water becomes more shallow (less than 1½ times the wave height in depth - known as the critical depth) the orbital motion of the water particles is influenced by the bottom. Although the wave period remains unchanged, the wave length is shortened. As a result, the wave height increases and the wave crests become more peaked. The wave steepness increases until it reaches a critical value about 1/7th. At this point the wave crest peaks sharply, becomes unstable, and breaks. Waves usually break when the water depth is 1.3 times the wave height.

Energy from a breaking wave frequently causes a new set of smaller waves to form. These waves also break when they reach shallower water. Thus the surface zone may have several sets of breaks, depending on wave conditions and near shore bottom configuration.

It is interesting to note that when waves break they expend their energy through the turbulence of the water and by washing up on the beach. In these final stages, the wave's energy is changed to heat energy. If this heat energy were not thoroughly mixed with large volumes of sea water it would cause an appreciable temperature rise in the surface zone.

On a steep sloping shore the crest of the breaking wave overhangs and falls in front of the wave and is known as a 'plunging-breaker'. On a gentle slope the crest sharpens and the foam spreads down over the front of the wave forming a 'spilling break'.

In shallow water the waves, unlike those in the open sea, become an actual shorewards movement of water, carrying in driftwood etc.

It is on open beaches that have gentle slope and so produce spilling breakers that surfing is possible.

Backwash, Under Tow & Rips.

Its force spent, the wave retreats. This is known as backwash. Part of its water moves beneath the advancing waves and this is known as the undertow.

The rip is really worth considering as it can be dangerous unless you know what to do if caught in one. A rip is caused by the sea moving parallel to the beach scouring out a groove e.g. beyond which is a bar of shingle or sand. Where there is a gap in the bar the sea sweeps violently out causing a rip which is normally quite narrow. If caught in a rip the answer is to swim parallel to the shore and therefore out of the rip.

Clapotis.

Waves on meeting a sea wall may not break but simply reflect back to seawards. Two sets of waves then momentarily combine to form a high crest between deep troughs before passing on unchecked. In deep water when this happens the two wave patterns synchronize to form a series of clapotis. These are stationery standing waves.

An excellent example of clapotis

Blowing rough!