CHAPTER SEVEN

NAVIGATION

Some years ago when I lived on the Isle of Wight off the south coast of England I was asked to talk on this subject to a local canoe club on the mainland. Having caught the ferry I took a taxi. The taxi driver and I spent an hour looking for the club premises. We never did find it and I caught the ferry home again. It struck me as ironic that I had to get lost when I was to give a presentation on how to find one's way!! The lesson, clearly, is to spend some time in preparation. A little map reading and a phone call to someone at the canoe club would have led me straight there.

The principles of 'finding one's way' are the same wherever you are; up a mountain, along the high street in a city or out on the ocean. The art of navigation is familiar to all of us and it is a pity that mariners have tended to cloud it with some mystery. I suppose this goes back to the early sea traders who had a vested interest in maintaining monopolies over lucrative trade routes and only passed on navigational information to close trading partners.

The Portuguese were among the first true navigators who kept records and drew up charts so that others may follow. In particular we have King Henry - born in Portugal in 1394, to thank. Known as "Henry the Navigator', at the age of 19 he was assigned the task of building a fleet that was to form a Portuguese armada. Later Henry initiated and organised sea faring expeditions to the 'frontiers of mystery' and he made his base along the southern end of Portugal, SAGRES, a centre for cartography and navigation. He knew the unknown could be discovered only by clearly marking the boundaries of the known. This meant discarding the junk caricatures drawn by Christian Geographers and replacing them with cautious, piece-meal maps built up on an incremental basis. Prince Henry required his mariners to keep accurate log books and charts and to note for their successors everything they saw of the coast.

In case navigation is a mystery to you, let me try and make it clear.

As I said a moment ago, navigation is indeed familiar to us already. You will have decided on travelling to a specific destination. You will work out how long it will take to make the journey. Usually you do this without any conscious thought, particularly if it is a journey you do fairly frequently. When determining the journey time you will consider the distance involved and your estimated speed. Assuming you choose to go the most direct route, then the only influence you can have over the journey time, is that of speed. This is usually determined for you in that much will depend on the road conditions. Is there 'rush-hour' traffic on narrow roads, or is it that you travel down an empty motorway. Of course, you also have influence over the route in that you could choose the scenic route or the fastest route. You know how to choose routes in towns and cities. You rely on either knowing your way round, following route directions or using a map. Which ever, you will be using identifiable features to ensure you stay on your chosen route. These features are usually public houses here in the U.K. We have so many of them that local directions are nearly always given based on 'pubs'. "Take the next left by the 'Dog and Whistle', go past the 'Queen Victoria' and turn second right'. We may use churches, large buildings or even street names. When we walk among the hills and dales the map will help us identify prominent peaks. We will use these pubs, churches and peaks to assist with getting ourselves properly orientated, so that we remain on course for our destination.

Describing land or terrestrial navigation crudely; it is easy to head in which ever direction you wish quite accurately once you have clearly identified a landmark. All you do is hold your compass in front of you and then turn the actual compass housing (bezel) to align the needle (which always points Magnetic North) with the north on the compass housing and then read off the direction of your landmark in front of you. If the landmark lies due west of you, then obviously you are stood on its eastern side. The trick is knowing just how far away you are from the mark. Should you be aware of this then you have identified your position. Consequently the next bit of information you need is the distance to your destination.

Of course this is very simplistic and I will discuss the basic elements of compass work and route finding as applied to the sea (marine navigation) in a moment. The problem with the sea is finding the marks. There are no pubs, churches or mountain peaks out on the ocean. Here we rely on accurate time pieces, a sextant and heavenly bodies (sun, moon and stars - not satellites!!). Our sort of navigation does not normally involve sextants. We rely very much on identifiable marks such as coastal features, buoys and shipping lanes. In other words coastal navigation.

COASTAL NAVIGATION

EQUIPMENT NEEDED

Navigation has been defined as the business of finding out where you are, proceeding in the right direction to wherever you want to go and ensuring firstly, that the route you have chosen is a SAFE one, and secondly, that you stay on your proposed route. Probably the most useful simple instrument to a sea kayaker attempting to navigate is his own eyesight. To enhance this sense a good pair of BINOCULARS are very useful. Secondly, you must have some means of indicating direction. True, you know the sun rises approximately in the East and sets approximately in the West, but how are you going to tell direction when the sky is overcast or you and your kayak become enveloped in fog? So you must have a COMPASS.

Finally, you must have CHARTS and guides to inform you about the sea area you are navigating. Guides come in the shape of SAILING DIRECTIONS or PILOT BOOKS, there are also other nautical publications of an essential nature such as TIDE TABLES and TIDAL STREAM ATLASES. To plot lines of direction and positions on your charts you will need certain chart instruments such as DIVIDERS, RULER, PARALLEL RULER and/or PROTRACTOR.

BINOCULARS

Kayaking conditions impose some special requirements on the type of binoculars you should use. For example, they should be waterproof and resistant to damage by the erosion of salt, air and water. The magnification must not be so great that they become virtually useless when used from a kayak moving up and down on the water. They should also reduce or eliminate sunlight glare from the water and be suitable for light variation from high noon to semi-darkness. These requirements narrow the range of suitable marine binoculars down to about three types; 6x30; 7x35 and 7 x 50, all with coated lenses. These type numbers, denote two important characteristics of a binocular. The first number refers to AMPLIFICATION so that a 6x30 type indicates that an object viewed will appear six times as large as when seen by the naked eye, or as one-sixth the actual distance away. If you were to raise this 6-power amplification to say, 8, then the object would appear only one-eighth the distance away but the movement of the kayak on the water usually means that the buoy number you were able to read at 1200 yards with 6-power, although larger, may now be jumping around so much as to be undecipherable. The second type number, refers to the diameter of the OBJECT LENS - that is the one furthest from the eye - expressed in millimetres. The larger the object lens the more light it can gather. The ratio of this to the amplification factor determines the amount of light which reaches the eye through the eye-piece of the binocular. Clearly the 7 x 50 are at the top of the usable range, but tend to be more costly as well as more bulky. The less expensive 6 x 30s are OK for general spotting during daylight, but you will find the 7 x 50s that much more useful in fading light.

COMPASS

I will spend some time on the theory and use of the compass shortly. Compasses commonly used on kayaks include deck mounted marine compasses, hand-bearing marine compasses and hand-bearing walking compasses. An important difference between walking and marine compasses is the way each type is read. Marine compasses have the circular scale of the numerical direction attached to the needle whereas walkers compasses have this scale attached to the compass housing on a ring that can be rotated around the

needle. When a marine compass turns, as it turns when the kayak turns with its compass deck mounted, then the numbers remain stationary, and the index mark on the housing circles the numbers to identify compass direction.

On a walkers compass the numbers turn with the compass, so they must be rotated into alignment with the needle by hand before a compass direction can be read. Marine compasses are covered by a dome or convex cover so that the card can be read as the kayak tilts and yaws, whereas the flat walker compass tend to stick when tilted. A deck mounted marine compass can be read in a sea way without there being a need to handle the compass at all, whereas the walkers compass relies on being kept level by hand as the numbers ring is rotated to align NORTH with the needle position.

Walkers compasses often have an adjustment to offset the NORTH position for the local magnetic variation so that true directions can be read directly from the compass. This is convenient for land navigation using topographic or Ordnance Survey maps. This is not an advantage to marine navigation using nautical charts. Marine compasses suitable for kayaking do not usually have an adjustment for magnetic variation, but there are models with a rotating bezel which allows the kayaker to offset for Variation

There are also differences between marine compasses. Large, well damped deck compasses can be read reasonably well as the kayak rolls and the compass is set well forward (to allow room for charts) whereas the less expensive models are not so useful in this respect.

I have my SUUNTO Sail Racing Compass mounted on a wooden plinth so that the plinth fits with the contour of the deck. It is held in position by short lengths of strong deck elastic shock-cord so that removing it to prevent theft or damage is easy enough. Further more, as it is mounted on wood, should it fall overboard (as it did once during a messy rescue operation), then it floats.

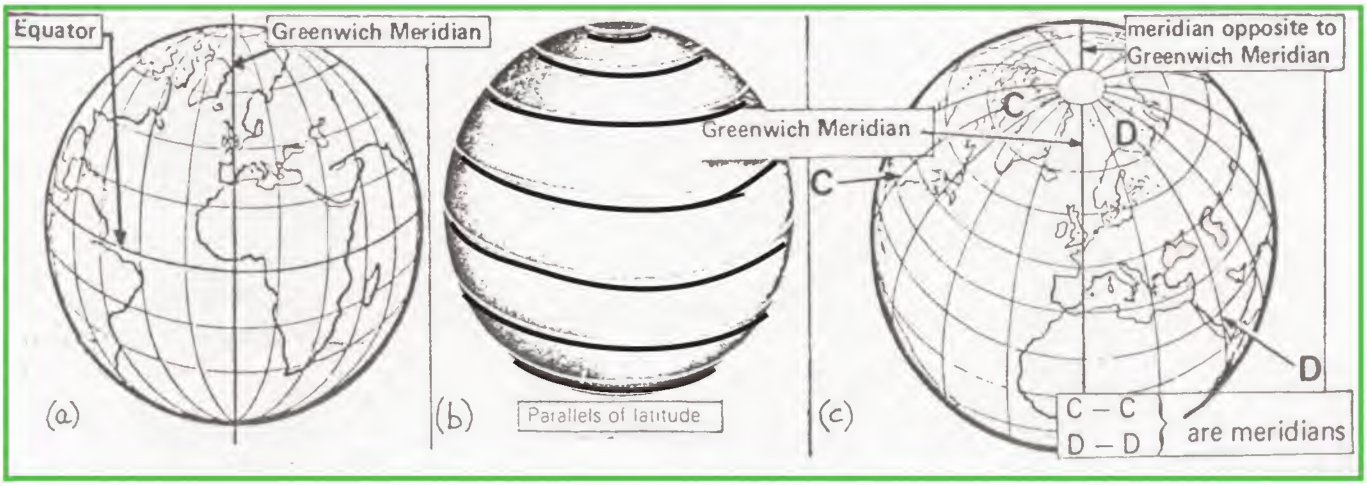
Deck mounted compasses are meant for steering. Being constantly in line of sight it will readily ensure you stay on course. Bearing to land marks or buoys can be taken with a deck mounted compass by pointing the kayak at the mark. Hand bearing compasses are stowed on the person as a rule, ready to be used to take the occasional sight either to pick a course or take bearings for a POSITION FIX. These compasses have limited value in rough seas as you can well imagine. They also differ among themselves. Some can be read to within a degree or so, others are less accurate. Some are well damped. There are two basic types. One is held at arms length, one to the eye. The latter is far more accurate and compact.

Night bearing sights require models with internal lights. Some rely on batteries. I have a MINI-COMPASS which has a cell of radioactive gas that emits electrons onto a phosphor that lights up rather as a TV screen does. It is held to the eye and the compass scale is seen as though projected onto the object being sighted. The manufacturers have eradicated the problem of parallax error (see glossary) which I have found particularly useful at night when taking bearings on an intermittent flashing light. A word about the problem of DEVIATION. Compasses work because the needle is magnetically attracted to magnetic north. Should any other magnetic influence interfere, such as a radio or another compass, for example, this will distort the accuracy of the reading. Beware. And another word about actually mounting your deck mounted compass. On the compass you will find a line or pointer. This is the LUBBER LINE. The compass must always be carefully mounted so that a. straight line from the centre of the compass card to the lubber line is exactly in, or parallel to, the fore and aft line of the kayak. The kayaks heading or COMPASS COURSE, is read from the graduated compass card against the lubber line.

And finally, a word about illuminating your deck mounted compass for navigation by night.. Some compass cards, (not many), are sufficiently marked with luminous paint, but if they are not, provision for a battery driven light should be made. The light must be no more than a glimmer and preferably orange in colour otherwise night vision will be impaired.

CHARTS

Probably the most important of all navigational aids is the chart - the map of the sea. upon which a navigator plots his position and plans his course. To understand how charts are constructed we need to consider the Earth as a sphere. The fact that the Earth is slightly flattened at both poles, is not too important. For our purposes we will accept that all lines drawn from the very centre of the Earth are indeed equidistant. Now in order to describe a position on the Earth's surface, it is only necessary to quote its shortest angular distance from two lines, perpendicular to each other on the surface of the Earth. These two

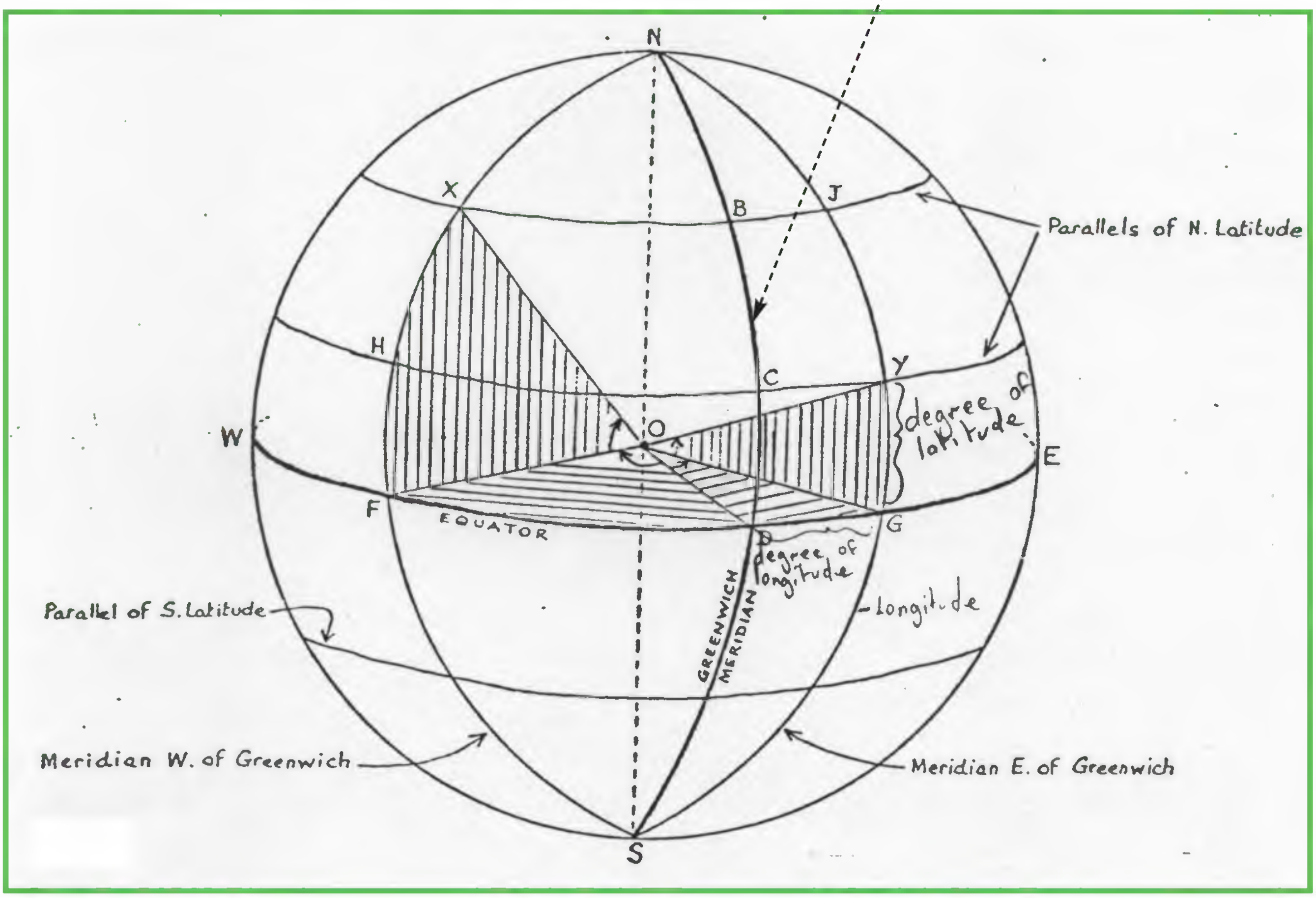


reference lines are the EQUATOR and the MERIDIAN OF GREENWICH (running through London).

THE EQUATOR is a particular great circle (refer to Glossary) on the Earth's surface whose plane is perpendicular to its axis of rotation or to a line joining the North and South poles. The Equator divides the Earth into the Northern and Southern Hemisphere as is the reference line from which LATITUDE is measured.

THE GREENWICH MERIDIAN is a semi-great circle through Greenwich Observatory. Early astromoners put forward a number of proposals for solving the problem of being able to identify LONGITUDE. This consisted of measuring the position of the Moon amongst the stars. In essence this method uses the heavens as a clock with the stars as a dial and the Moon as a hand. In theory, this method of using the fairly fast movement of the Moon against the background of stars offered the best hope of finding Longitude. In December 1674, King Charles II appointed a Royal Commission. Basically there were three problems facing this Commission. Neither the position of the stars, nor the movement of the Moon were known accurately enough for this method to work; nor was there an instrument that could measure the position of the Moon amongst the stars to the required accuracy.

Consequently King Charles II appointed John Flamsteed as 'astronomical observator'. It was Christopher WREN who suggested Greenwich as the site for Flamsteed's observatory and this was duly built in 1675 on the foundation of Greenwich Castle. The result of Flamsteed's work was published as HISTORIA COELLESTIS BRITANNICA in 1725. Now the precise position of the stars were known. It was Flamsteed's successor, Edmond HALLEY, who made the observations needed for accurately determining the Moon's orbit. With the completion of HALLEY'S observations of the Moon, the second set of accurate observations required for the lunar distance method was available. It was quite sometime (18th century) before mariners could use the work of Flamsteed and Halley. Almanacs and the sextant were needed first. With the publication of the Nautical Almanac the lunar distance method finally became the practical solution to the problems of finding longitude at sea. But this was only a short lived success as accurate marine chronometers came on the scene. It is because of the history of King Charles II observatory that the meridian passing through Greenwich is now accepted as the PRIME MERIDIAN.



LATITUDE of any place is the arc of a meridian between the equator and the parallel of latitude on which the place lies. Parallels of latitude are all small circles (see glossary) parallel to the equator, named north or south according to the hemisphere. Note that the latitude of the pole is 90 degree.

LONGITUDE of any place is the arc of the equator between the meridian of Greenwich and the meridian on which the place lies. Meridians of Longitude are all semi-great circles (see glossary), terminating at the poles and named east or west according to whether they lie east or west of the **Greenwich Meridian**. The continuation of the Greenwich meridian beyond the poles on the opposite side of the Earth is the meridian of 180 degree longitude (see figure above).

The position of any place can therefore be described in terms of latitude north or south of the Equator, and of longitude east or west of the Greenwich meridian. We are now able to identify our position in relation to these two reference lines .... but how? Let me explain.

We can see from the diagrams on Page 199 that the distance on the Earth's surface between any two meridians is greatest at the Equator and decreases uniformly until it is zero at the poles, where all the meridians meet. As an example, 30 degree of longitude at latitude 60 degree is 1,021 miles, whereas the same degree of longitude at the Equator is 1,800 miles. You can see that the linear distance of a degree of longitude on the Earths' surface varies with the latitude and cannot be taken as a standard measure of length. On the other hand, the distance on the surface of the Earth representing a degree of latitude is, for practical purposes, the same no matter at what part of the Earth it is measured. The distance between 0 degree and 20 degree M (or S) is the same as that. between 20 degree and 40 degree or between 40 degree and 60 degree. Because of this uniformity we can take a section and use it as a scale of measurement. There are 90 degree between Equator and Pole. We know there are 60 minutes in a degree so between Equator and Pole there are (90 x 60) 5,400 minutes. Consequently we take one of these minutes and call it a nautical mile, i.e. l/60th of a degree is equal to one nautical mile. We now need to determine the actual distance of a nautical mile and this is 1852 metres or 6076 feet.

CHART PROJECTIONS

So far we have been dealing with the world as a globe. The problem is transferring this three dimensional orb to a flat two dimensional form to give us a chart, that is projecting the globe onto a flat piece of paper so that we can draw courses and measure distances and angles accurately for navigational purposes. There are several practical methods of doing this, but unfortunately they all involve distortion of the Earths' true proportions in one way or another. Most sea charts are on the MERCATOR projection. This is a modified form of the 'central-cylindrical projection'. You need to imagine a transparent globe surrounded by a cylinder of paper. The globe has a bright light within its centre so that the land forms show up as shadows on the paper cylinder. The shadows are then traced and the paper cylinder then laid flat and there is a representation of the Earths' surface on a flat plane. This projection distorts the size and shape of the Earth as it casts the traceable shadows on the cylinder - land forms around the Equator are reasonable representations but land forms nearer the poles will be drawn from shadows that are somewhat elongated. We have to rely on the eventual construction of the chart to be mathematically formed so that (I) a constant course steered by a ship or kayak may be represented on the chart by a straight line so that courses may be adequately described, and (2) angles, such as course angles, are not distorted on the chart.

We normally use only a small portion of the chart at any one time, which allows us to disregard any small-scale distortions. There are two exceptions: -

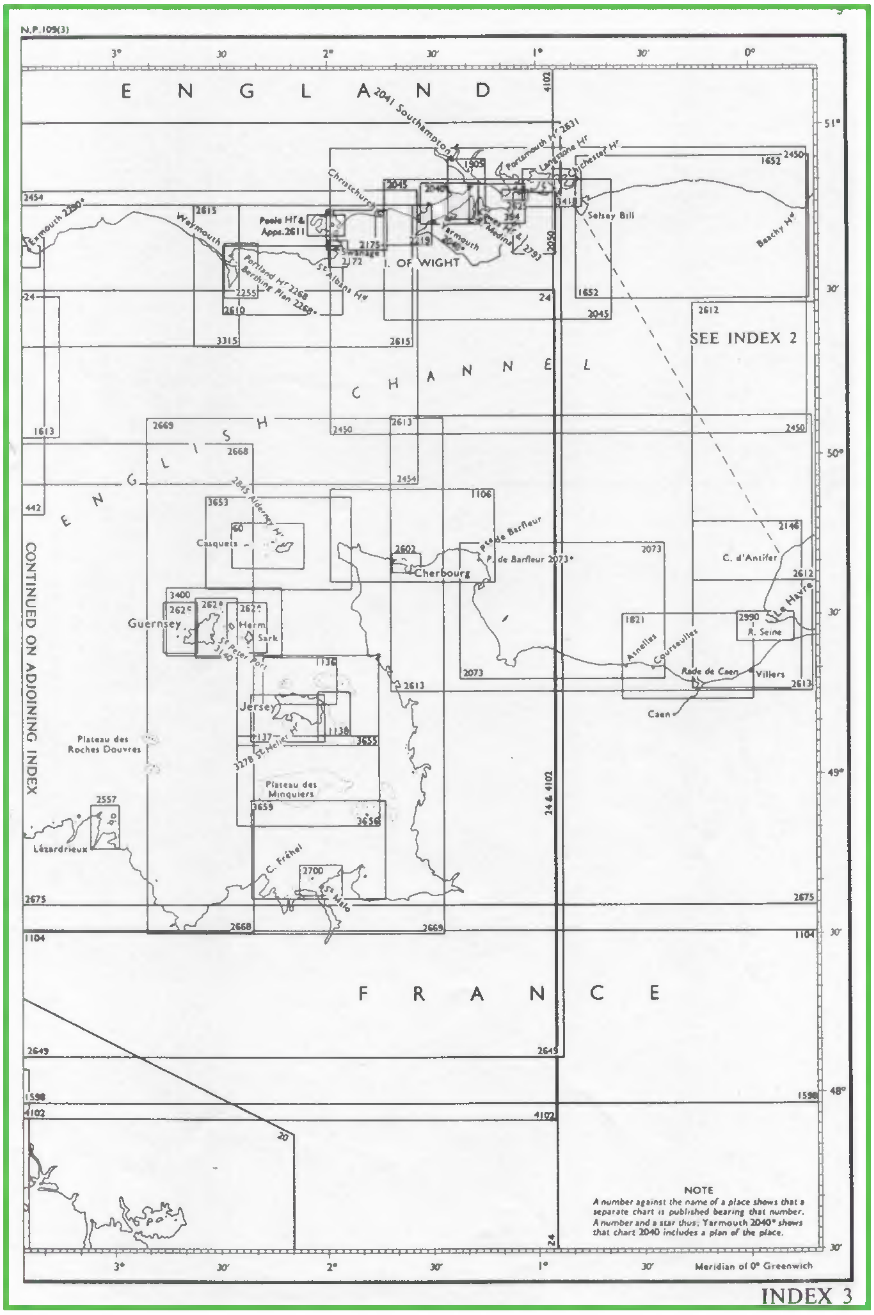
(1) The distance between parallels of latitude increases progressively from the Equator towards the poles on the chart, whereas you will remember that it is constant on the globe.

(2) The meridians, instead of meeting at the poles as they do on the globe, appear as straight lines parallel to each other and at a constant distance apart.

These two factors result in a progressive broadening and lengthening of all features as you move away from the Equator. The important point here is that although one minute of latitude always represents one nautical mile of distance, the length of one minute of latitude on the chart increases progressively from the Equator to the Poles (and therefore from the bottom to the top of any chart of areas within the Northern Hemisphere). When measuring distances on a chart, particularly on small scale charts, it is important to use the scale of latitude down each side of the chart adjacent to the area you are measuring.

CHARTS

Charts are maps used by navigators at sea which show all essential information to assist the navigator. Charts show contour lines of the sea bed and surrounding coastline. Note that a map or land map, gives the height of the land contours above sea level whereas a chart gives the depth of the bottom below sea level. A chart which represents a small area is called a large-scale chart and one which covers a large area is a small-scale chart. Large and small scale refers to the ratio between the size of details shown on the chart and their actual size. The natural scale of a chart is quoted under its title. If, for example, this is shown as 1/20,000, then this means that the area and details on the chart have been reduced 20,000 times. In other words 1 inch on the chart is equivalent to 20,000 inches of distance in reality. Obviously the large-scale charts covering small areas are going to have the most detailed information available and are therefore the ones we kayakers seek out.



Charts are now using metric units where heights and depths are expressed in metres/decimetres, instead of the Imperial fathoms/feet. These metric charts are readily distinguishable from fathom charts by their improved design and by the greater use of colour to make the charts more easily legible in daylight. Land areas are coloured buff. Drying areas are green. Shallow water is blue. Anchorages are magenta as are traffic routes

ADMIRALTY CHART CATALOGUE

To help you select the chart that is the most appropriate for your purposes, that is, it covers the relevant area and is of the larger scale that you need, refer to the Admiralty Chart Catalogue, or more precisely, 'The Admiralty Catalogue of Charts and Publications'. This catalogue is available, as a rule, at your local chandlers or chart agent. I have always found KELVIN HUGHES (previously known as Camper Nicholsons) in Southampton to be very helpful in that they respond to telephone orders.

I have the "Home Edition' of this catalogue which covers the coasts of the U.K. and Northern France. These catalogues contain index maps of all sections of the coastline on which the limits of each navigational chart published is shown, so that the chart for any specific expedition can readily be chosen.

CORRECTION OF NAVIGATIONAL CHARTS

When you purchase a new chart, as opposed to borrowing them, then you will have the advantage of an up-to-date chart with all recent corrections shown. For this reason it pays to check the date of publication of your new chart. This is shown in the middle of the bottom border. When a chart is corrected from important information which is too extensive to be issued as an ordinary Notice to Mariners', or to insert conveniently by hand onto existing copies or when a chart is revised throughout, then alterations are made to the chart plate from which all futures copies will be printed and charts from these revised plates are then issued as NEW EDITIONS, the date of this being shown to the right of the date of publication.

NOTICE TO MARINERS

The detail shown on charts can and frequently does change. To ensure these changes are noted and the charts altered accordingly, a 'Notice to Mariners' is promulgated. Such changes as the alterations to the position or description of buoys, light vessels, light sectors, newly identified dangers and so on are provided by these Notices. 'Notice to Mariners' are published weekly and are free from all Mercantile Marine Offices and Admiralty Chart Agents. They are also available on the Internet. The task of correcting charts is not beyond the wit of us amateur navigators who usually only keep a small number of charts, relatively speaking that is in fact I find it quite an interesting task and of course it does keep you 'au-fait' with new navigational aids or dangers. Corrections should be made in permanent violet ink unless the changes are Temporary or Preliminary, in which case they are made with pencil.

SYMBOLS AND ABBREVIATIONS USED ON NAVIGATIONAL CHARTS
Let us look at just what information, is available and how it is displayed on a Navigational Chart.
THE TITLE of a chart is shown where it will not obscure important features or information. It will define the general sea area and geographical limits of the Chart and with the title usually comes important information which may include:-
(1) details of the survey on which the chart is based
(2) the level below which depths and above which heights are expressed
(3) the units of depth soundings (fathom, or metres)
(4) the natural scale of the chart
(5) notes on tides and currents
(6) the date of the Magnetic Variation Curves (if any)
(7) 'Cautionary Notes' about dangers.

THE MARGIN of a chart also contains useful information. In the top left hand and bottom right hand corner you will find the Admiralty Catalogue number. With the number in the bottom right corner will be shown the year of the original engraving. In the centre of the bottom margin are the dates of publication. New Editions or Large Corrections (if any) and in the bottom left hand corner will be the numbers of the Notices to Mariners from which small corrections have been made.

DEPTH SOUNDINGS are shown by numbers distributed over the sea area and today these are shown in Metres and Decimetres. Always check the units of measurement. Generally this information does not interest us greatly, but sometimes dropping a line to gauge the depth may be, say in fog, one way of making a good guess at a position or at least a position line as you approach the coast. As the direct level of water at any point is constantly changing because of the tide, a datum level is used to which all depths are referred. Depths shown on a chart are expressed as depths BELOW Chart Datum and heights of tide (as given in Tide Tables) are measured ABOVE Chart Datum.

CHART DATUM is an arbitrarily fixed level devised so that it is below low-tide level (except for exceptionally low tides), so that a margin of safety is provided for boats drawing more water than kayaks. Running aground is no big problem, though I had a job persuading Mike and Jonathon on our Wash crossing from Boston to Hunstanton, some years ago. We ran aground on thick oozy mud. When we tried portaging (carrying over) we sank to our knees. We decided to sit and wait for the tide to come in and rescue us - three mud covered figures, through which only three pairs of eyes showed through. We had lunch, of thick mud covered sandwiches. Once we eventually got underway, the tide was resisting our passage, it became dark, wet and windy and we had to head inland. To finish this story I can tell you matters deteriorated yet further and landing was made difficult by high water flooding the length of shoreline to cover the marshy land, making it impossible to walk over. The lesson has to be that you need to study your drying heights, at least you need to as you attempt a crossing of the Wash on the east coast of England.

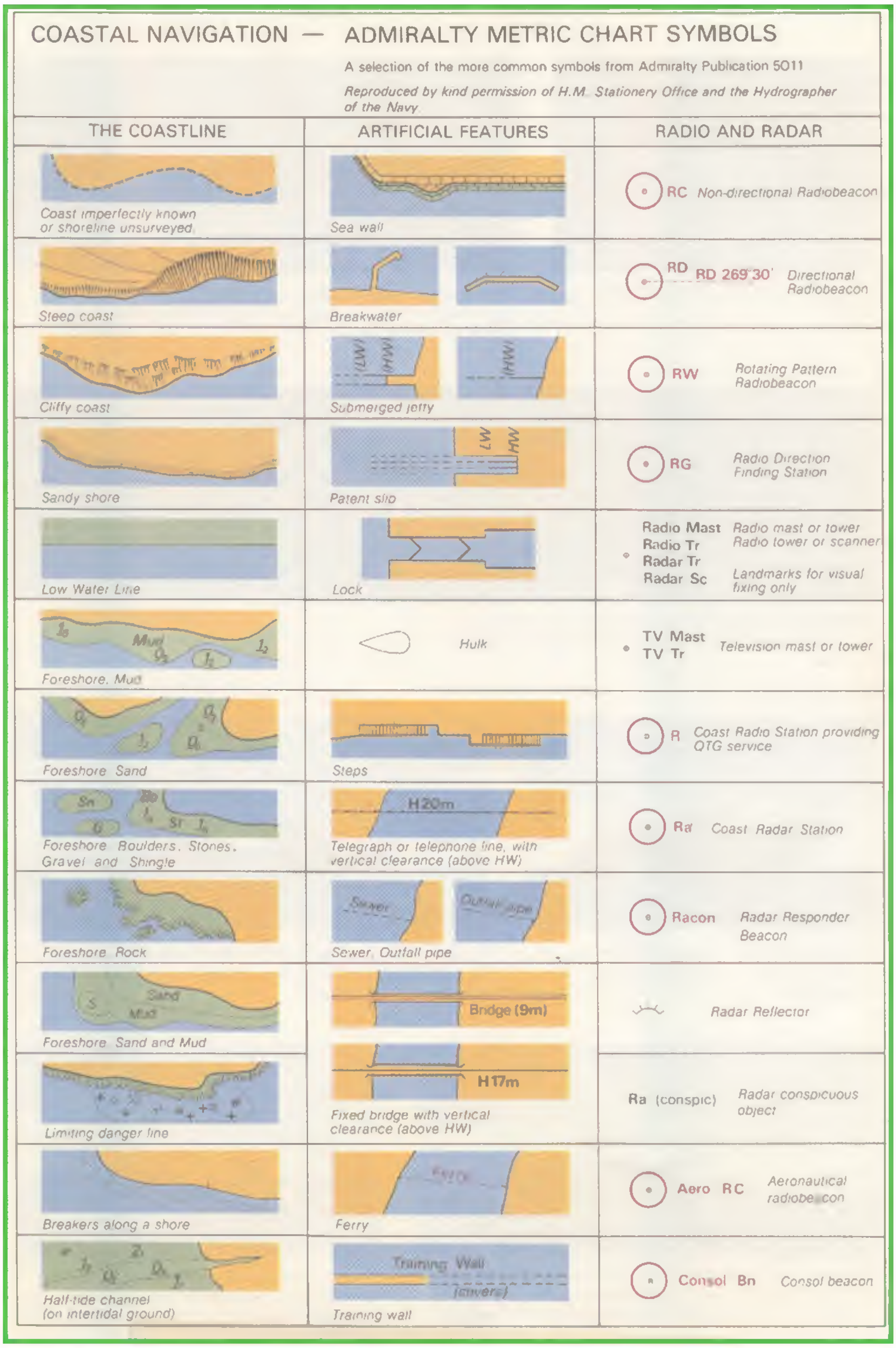
As the tide rises and falls so the shore is covered and uncovered by sea. This part of the shore line is depicted green on metric charts and is called the foreshore. Features such as rocks, wrecks etc. are also covered and uncovered by rising and falling tide. The figure given against these features is their drying height or their height ABOVE chart datum and is always underlined.

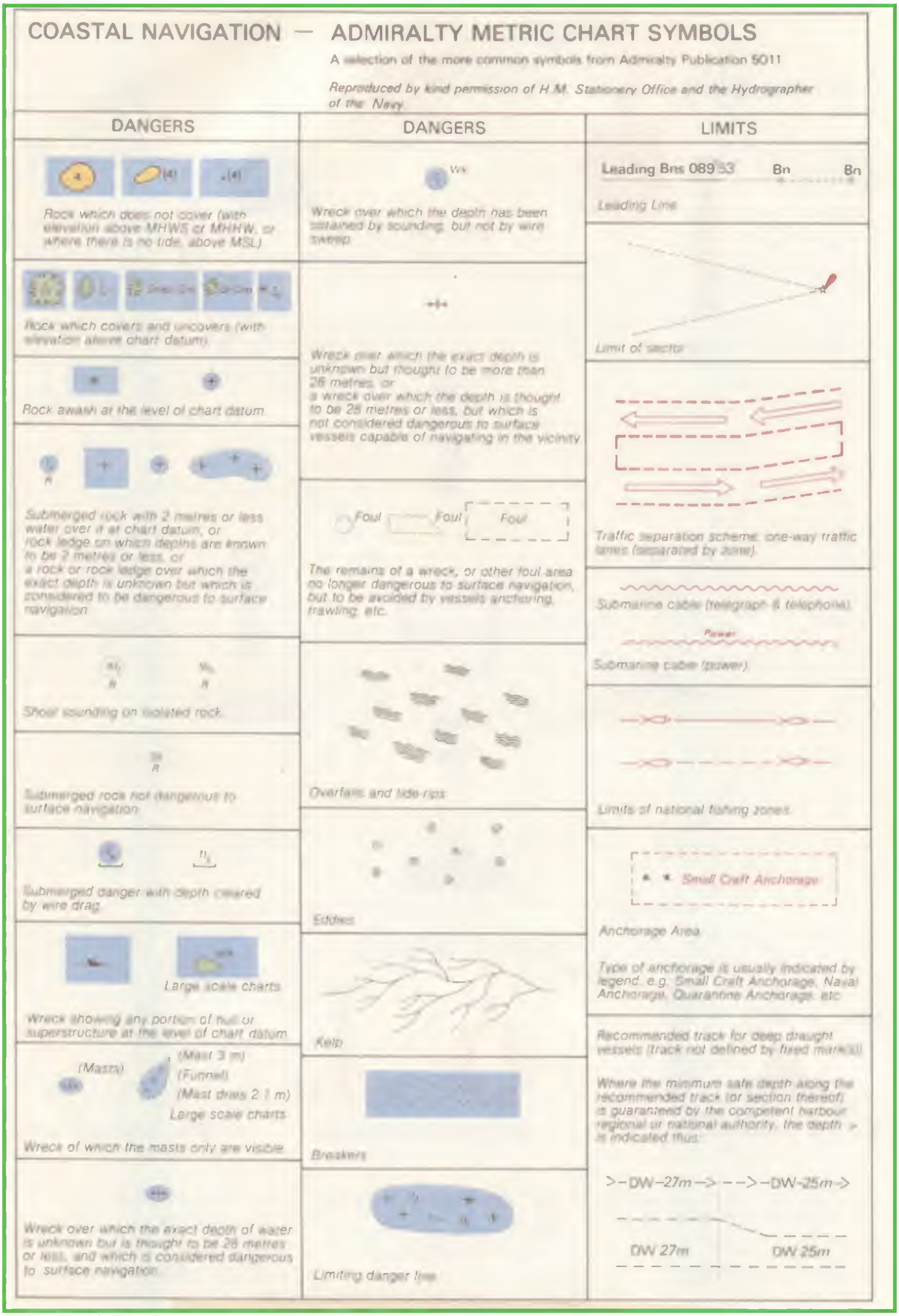
DEPTH CONTOURS are lines joining soundings of equal depth just as contour lines on an Ordnance Survey or topographical map shows the height contours of hills and valleys. On metric charts depth contours are shown in continuous hairline broken at intervals by the figures showing the actual depth. In general metric charts are tinted blue up to the 5 metre contour line with a ribbon of blue tint on the shallow side of the 10 metre contour line.

NATURE OF THE SEA BOTTOM is given on most charts by letters placed below certain soundings. For example; gy. M = grey mud; so. Cy = soft clay. In general capital letters are used for names and small letters for descriptions. The value of this information lies in the ability to compare a specimen, taken by a hand lead, with that given on the chart, again a useful guide to position perhaps in thick fog.

HEIGHTS OF LAND FEATURES such as mountain peaks, lighthouses, cliffs, etc. always refer to the height above the level of Mean High Water Springs. The height given for a lighthouse always refers to the height of the focal plane of the light and not to the top of the lighthouse itself.

SYMBOLS AND ABBREVIATIONS USED ON ADMIRALTY CHARTS. These are all clearly shown in Admiralty Chart No. 5011, which is not a chart at all, but a booklet. This 'chart' illustrates all the symbols and abbreviations and every serious sea kayaker should own one as the ability to read a chart correctly depends upon familiarity with these symbols. I have included a fair sample of some of the metric chart symbols on this page.

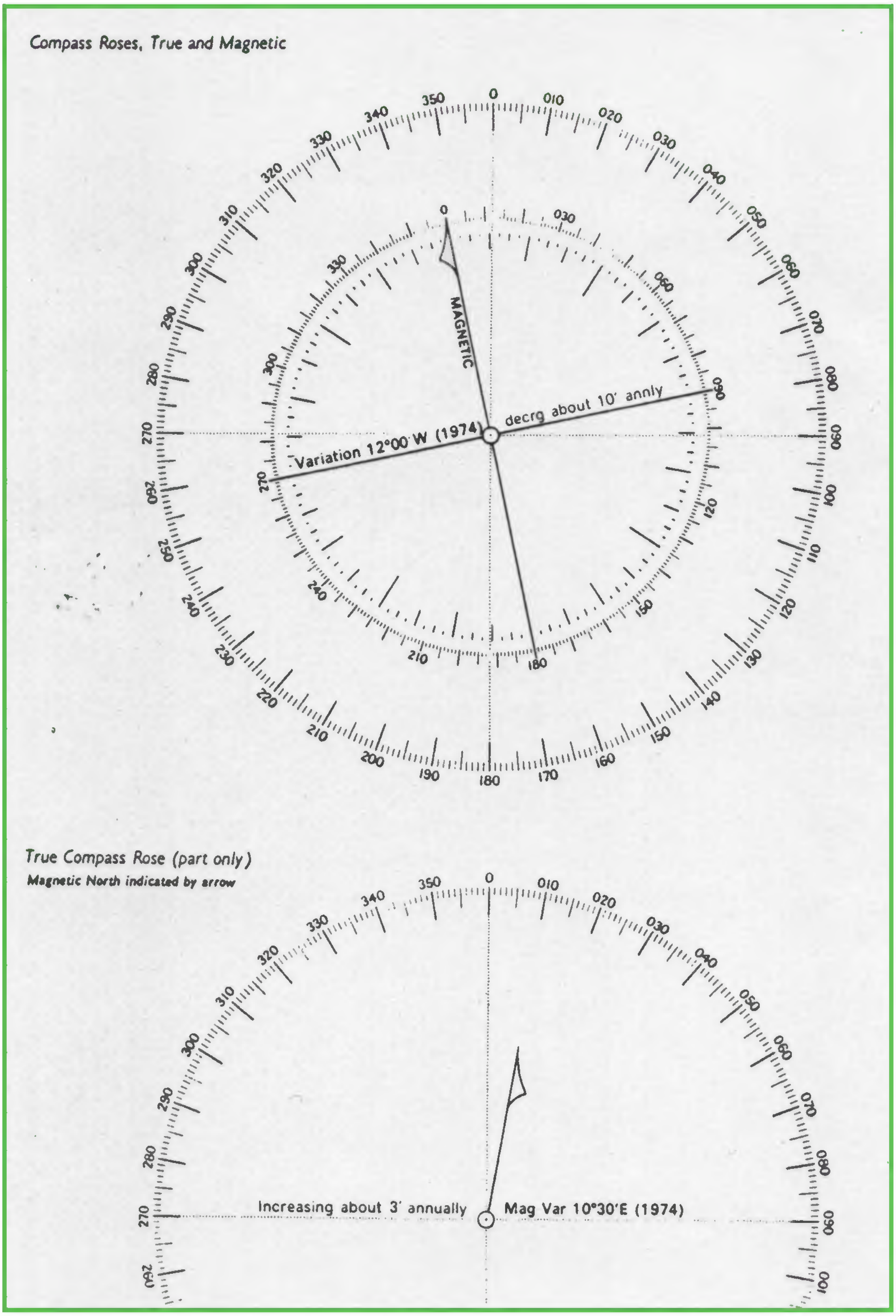




Memorise the following symbols:-
(I) Rocks (2) Wrecks (3) Overfalls (4) Eddies (5) Lights and lighthouses
(6) Light vessels, buoys and beacons (7) Landmarks such as monuments, chimney
COMPASS ROSE.

Every chart has a compass rose printed on it, even more than one in many cases. Their purpose is to enable COURSES and BEARINGS to be measured with the aid of a parallel ruler. Sometimes there are two concentric rings of graduations on a compass rose and sometimes only one. When there are two concentric rings the outer ring represents the True Compass and the inner ring the Magnetic Compass.

On the compass rose in the figure illustrated, you can see these words "Variation 12 degrees West (1974) decreasing about 10' annually". This refers to the variation between True and Magnetic headings.



SEA TRAFFIC SEPARATION ROUTES

On one particularly long crossing with Peter Midwood we had to turn and head back to our departure point. As we had not prepared for this eventuality, we had to rethink the effect of tidal influence and make the best guess as to our heading. We were many hours from sighting land and we were keen to land at the right point so that we could recover our vehicle. On this occasion we watched the large vessels move along their appointed 'traffic lane' and we identified the lanes on the chart and were able to use this to confirm our set course. Crossing the English Channel means crossing first the south going lane, then the separation zone and finally, fairly close to the French side, the north going lane.

Shipping lanes can be quite useful in helping to identify your position but the busy ones, for example as found in the English Channel, can be very difficult to cross, particularly in a rough sea. Someone once likened it to trying to run across a busy motorway, and so it can be. You might be surprised at just how fast they travel and how close they are in convoy. The symbols used for Sea Traffic separation Routes are shown in magenta and are illustrated in the symbols shown on Page 193. These separation routes have been established in many areas of the world where shipping is busy. Of course they are designed for large ocean going vessels, but we as kayakers should know of their existence. We should always cross them at right angles to stay within maritime law.

NAUTICAL PUBLICATIONS

There are a wide range of useful publications available to help us with planning our routes on the sea. I am often asked for advice from kayakers planning expeditions, particularly to distant foreign parts, and I invariably reply by referring them to the readily available information found in charts, topographical maps, tide tables. Admiralty Pilots, etc. etc. Half the fun of planning any expedition is the research needed to determine best time to go, best route to take and dangers to avoid. Let us look at some of the publications of particular use to us as kayakers. Remember that much of the professional literature is written for the deep-sea navigator. Having said this, there are many useful guides and inshore pilots produced by the sailing fraternity which can be very relevant to kayakers.

NAUTICAL ALMANACS

This is an annual publication containing data on the Sun, Moon, Stars and Planets for each day of the year, for the purpose of astro-navigation only, as produced by H.M. Nautical Almanac Office in U.K. and U.S. Naval Observatory. On its own it is of no value to us unless we want to try our hand at this particular aspect of navigation for the fun of it. Let me recommend it. The commercially produced Almanacs also contain a wealth of data of considerable value and use to the coastal navigator, including information on radio aids, tides and tidal streams and visual aids to navigation round the home coasts. Reeds Nautical Almanac' is familiar to most of us. This is published by Thomas Reed Publications Ltd., Hazelbury Manor, Corsham, Wiltshire, SN14 9HX.

PILOTS (Sailing Directions)

These are published in about seventy-five volumes, covering the World. Six are devoted to the coasts around the British Isles and they can make fascinating reading to the kayaker planning his or her expedition. As I write, I have to hand the 'ARCTIC PILOT* Volume II, the one I used when planning my trip to East. Greenland a few years ago. Flipping through it once more it brought many memories flooding back. The first chapter contains a brief description of the country or countries covered by the Pilot, their government, flora, fauna, trade and currency, followed (in all volumes) by details of meteorology, tides, tidal streams, currents, signals, cautions, buoyage systems, radio and communication systems, standard times and fuel supplies. Succeeding chapters contain detailed descriptions of the sea areas and coast lines covered by the volume. The largest scale charts of the area being described are quoted at the top of each page and the general charts of the area at the bottom.

A new edition of each volume of Sailing Directions or Pilot is issued about every twelve years and a supplement to each volume is issued bi-annually. Whenever the Pilot is being consulted the most recent supplement should also be checked to ascertain whether there are any alterations or additions to the information being sought. Should information given on charts and in the Pilot differ, then the information given in the largest-scale chart should be accepted as the most accurate. Pilots can be obtained from

Hydrographic Department,
Ministry of Defence,
Taunton,
Somerset

or by ordering from most chandlers.
In addition to the official Admiralty Sailing Directions, there are a number of excellent books published commercially, giving sailing directions for inshore areas. One I have just taken from my library, is Mark Brackenbury's 'SCOTTISH WEST COAST PILOT' published by Stanford Maritime. The photographs and very detailed drawings of charts make it a wonderful reference book. The photographs showing the sea with distant views of hills and landmarks are always taken in good weather ~ do not be fooled!!

ADMIRALTY LIST OF LIGHTS, FOG SIGNALS AND VISUAL TIME SIGNALS - or the "LIGHTS LIST' for short, is published in twelve volumes covering the world.

Volume A' covers the British Isles. A new edition of each volume is published about every eighteen months and corrections are given in all editions of 'Notices to Mariners'. These "Light Lists' contain detailed descriptions of all navigational lights (except light buoys) and fog signals. Reeds Nautical Almanac (see Page 197) contains a Light List covering the British Isles.

TIDE TABLES
'Admiralty Tide Tables' are published in three volumes annually covering the World. Volume I covers European waters. Each volume is divided into two parts. The first giving daily predictions of the time and heights of high and low water for a selected number of STANDARD PORTS and the second giving data for prediction at a much larger number of SECONDARY PORTS. (See page 176 for guide to use of this information). Of course most of us make do with locally produced Tide Tables. I have to hand the small set of tables for Cowes, Southampton, Portsmouth and Dover sold for just over one pound. This booklet contains Tidal Constants (refer page 176) for selected ports on the South Coast together with courses and distances for Solent and Southampton Water, Measured Mile Speed Tables, Calendar, Sunrise and Sunset Tables, Conversion Table - nautical to statute miles, Beaufort Wind Scale and BBC Radio News and Shipping forecasts, VHP' Coast Radio Stations - not bad for a pound. Before I close this paragraph let me quote from my local Tide Tables "Meteorological conditions nearly always affect both times and heights of tides accordingly the heights given should be used with care". Rarely is this critical to us as kayakers but it can be worth remembering.

ATLAS OF TIDES AND TIDAL STREAMS
This is again published by the Admiralty and is known as the 'Atlas of Tides and Tidal Streams, British Islands and Adjacent Waters' and contains charts illustrating the direction and rates of the tidal streams around the British isles based on the times of High Water at Dover. There is also available a series of pocket tidal stream atlases, each one covering a specific area around the British Isles. Tidal steam diagrams are also given in the commercial Nautical Almanacs. I refer you to the illustration on Page 170

ADMIRALTY NOTES TO MARINERS
(also Ref. page 193) These notices contain information for the correction of Admiralty Charts and publications. They are numbered consecutively from the beginning of each year and are published weekly. Weekly Admiralty Notices to Mariners can be obtained free of charge from Admiralty Chart Agents and Depots, from British Mercantile Marine Offices and Customs Houses as well as from the Internet.

The contents of these weekly editions come under six sections: -
SECTION I give the numerical and geographical indexes for
SECTION II gives all daily notices published during the week starting with notices concerning the publication of new charts, new editions and large corrections to charts, new navigational publications or new editions of the same furthermore this section also contains notices giving all the instructions necessary to make corrections to charts, giving the Admiralty Catalogue number of the chart.
SECTION III gives navigational warnings
SECTION IV amendments to areas dangerous to mines
SECTION V corrections to Admiralty List of Lights
SECTION VI corrections to Admiralty List of Radio Signals.

THE ART AND SCIENCE OF NAVIGATION

Every navigator should try to cultivate 'navigational sense'. This means keeping a constant hold on your sense of direction by learning to estimate speeds, distances and general directions; not being deceived by appearances, recognising obvious mistakes early and having a sound understanding of the basic methods. A sense of direction does not necessarily mean relying on instinct. It means remembering simply things such as; the sun rises in the East and sets in the West and at noon bears South (in the Northern Hemisphere) an that the pole star always bears North. More transient features can help such as prevailing wind directions, the direction the waves appear to be moving towards.

COURSES AND COMPASS

> ***He was thoughtful and grave - but the orders he gave***
> ***Were enough to bewilder a crew,***
>
> ***When he said 'Steer to starboard, but keep her head larboard',***
> ***What on earth was the helmsman to do? '***
>
> Carrol

I have briefly explained compasses previously; now I want to discuss their use and application.
In the 17th century it was discovered that the Earth itself is a vast magnet whose poles attracted one end of a magnetised needle. The 'south end,' of the needle points to the North Pole and the 'north end' to the South Pole. This is in accord with the rules of magnetism which say .... 'unlike poles attract, like poles repel'.

VARIATION

Since the 17th century it slowly became obvious that the magnetic poles could not be in the same place as the geographical poles; and, furthermore, that the magnetic poles were not stationary but changing their position over long periods of time. This accounts for the compass needle not pointing accurately to the geographical North but instead to the Magnetic North. This difference is known as VARIATION. Thus the ANGLE OF VARIATION is the angle subtended by (1) the needle pointing to magnetic north (given that there is no deviation - see below) and (2) an imaginary line pointing directly to geographical north, also known as TRUE NORTH. The magnetic poles move very slowly over time to one side or the other of the geographical poles. If the magnetic north lies to the west of true or geographical north it is known as a WESTERLY VARIATION. If it lies to the east then clearly it is an EASTERLY VARIATION.

To convert a magnetic direction into a true direction we must add East (+), i.e. apply it clockwise; and subtract West (-) or apply it anti-clockwise.
To convert a true direction into a magnetic direction we must subtract East (-) variation and add West (+) variation.

Summing up, VARIATION **EAST - MAGNETIC LEAST VARIATION WEST - MAGNETIC BEST**

Variation then is the difference between TRUE and MAGNETIC, it depends on position, it changes slowly and is recorded on Admiralty Charts. At the present time the variation in the U.K. is westerly and is decreasing annually by about six seconds of arc. Obviously variation is also dependent on the location of the compass. Given that in the U.K., for example, it is 4 degree westerly, - as one moves right along the Greenwich Meridian to the high Arctic so the needle points further towards the west.

The details of current variation changes can be found on the compass rose on the chart. It will show the year at which the line pointing to magnetic north is given with the rate of annual change.

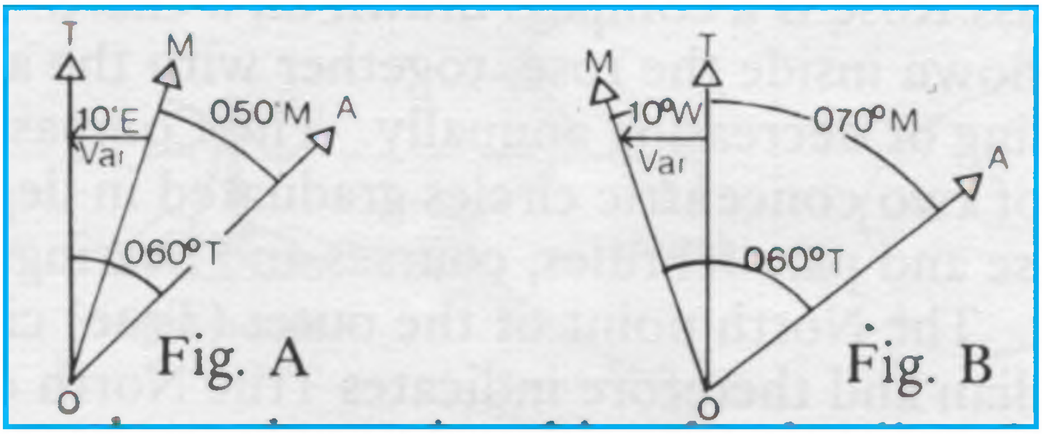
DEVIATION

As if variation was not enough for us to worry about there are also other causes for the needle failing to point directly to magnetic north and any such difference is known as DEVIATION. Deviation is important to larger vessels on which there is much to distract the compass needle. This distraction tends to vary with changes in the ships heading (or direction), hence the need to occasionally 'swing' the ship to determine the amount of deviation point by point.As kayakers we simply need to remember not to stow any metal or magnetic items such as VHF radio, metal pans, cooker, etc. too close to your deck compass. I recall going round in ever decreasing circles and not being able to make sense of my compass course. I realised my small walkers compass was interfering with the main deck compass.

COMPASS COURSE

In practice once you have measured the TRUE COURSE from the chart, from departure to arrival point, then you must convert to COMPASS COURSE. Similarly, compass bearings taken to fix your position will have to be converted to TRUE before they can be plotted on the chart. How this is done is one of the most important fundamental principles in navigation: and to assist with the calculations, which are quite simple, it is important to use the 'three figure notation' when describing direction.
For example - not 8 degrees but 008 degrees.
In effect we have three norths:-
(I) TRUE NORTH
(2) MAGNETIC NORTH
(3) COMPASS NORTH
The first two you are now familiar with. The last one, compass north, is the direction the compass needle actually points to when under the influence of variation AND deviation. As a rule, given that we are careful to prevent deviation, kayakers need only to worry about the difference between TRUE and MAGNETIC courses or bearings, because MAGNETIC and COMPASS should be one and the same.

In Figure (A) OA is a bearing or course 060 degree from the True Meridian and 050 degree from the Magnetic Meridian - the variation being 010 degree East. In Figure (B) OA is again 060 degree from the True Meridian but it is now 070 degree from the Magnetic Meridian because the variation is 010 degree West.



As paddlers we normally convert from TRUE to MAGNETIC and hope that MAGNETIC equals COMPASS.
When converting from TRUE to COMPASS, an easterly variation is subtracted and a westerly variation is added, hence our aide- memoir .
VARIATION WEST - MAGNETIC BEST
VARIATION EAST - MAGNETIC EAST
or
C.A.D.E.T. - **C**OMPASS **ADD** **E**AST TO GET **T**RUE
Before we go on to actually apply this information to actually work out our compass course, in order to achieve a sea crossing, I want to define a few other useful pieces of information.

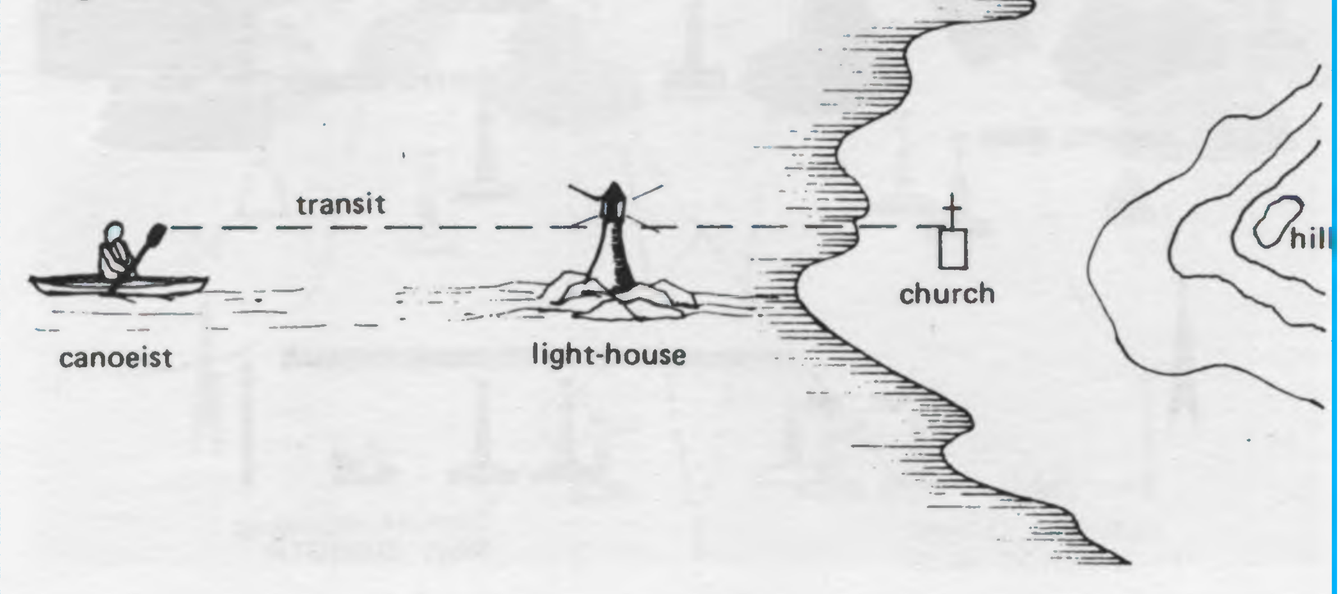
DEDUCED RECKONING.
The Deduced Reckoning or DR position is calculated by allowing for the kayaks true course and speed through the water since leaving a known position.

THE ESTIMATED POSITION
The Estimated Position allows for the best estimate of tidal stream and leeway being applied to the DR position. In other words it is the best estimate of the kayaks position over the ground allowing for course (direction or bearing) speed, tidal influence and leeway since the last known position of the kayak.

LEEWAY.
When paddling with the wind on one side, the wind will obviously move you along its direction. The difference between the course you are steering, given that you have built in to this course the effects of the tide, - and your actual course (often called 'the course made good') is known as leeway. Leeway may be defined as the angle between the wake and the fore and aft line of the craft. As kayakers do not leave a wake - well certainly I do not!! - I only include this to help definition.

FIXING BY TRANSIT BEARING.
A Transit Bearing simply consists of taking two prominent landmarks and lining them up and keeping them lined up as you paddle so that you. continue to head in your required direction. The advantage of a transit is its certainty. Given that the features are clearly charted such as a tower, lighthouse or peak and that you have two of them in line of sight then clearly you are on a position line as extended, by the two chosen features.

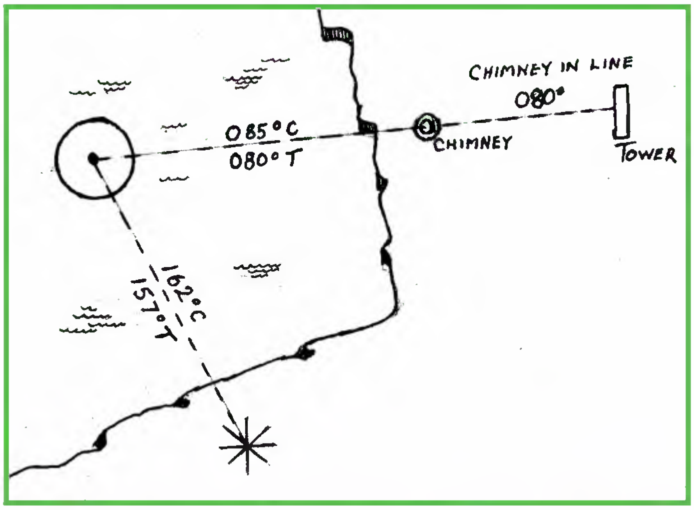
Diagram 12 A Transit.



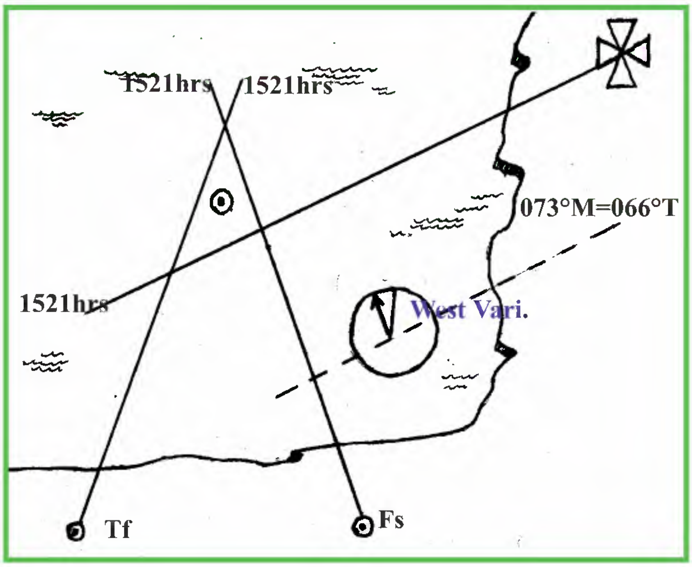
You can then make a very rough estimate of your position along the line. To get a lot more accuracy you need to plot two, better still, three, such transit lines as described below. It is good practice to take a compass bearing of the transit and to check it against the bearing from the chart in order to make sure the features have been correctly identified. Where the bearings of transits or leading marks are shown on the chart (or in sailing- directions), they are TRUE bearings from seaward so it is necessary to apply variation. Taking such a bearing is also a useful check on the compass. By lining up on a transit and then sitting the kayak without paddling, the set and drift of the tide may be established. This is always useful information.

TAKING A FIX.
If two transit bearings can be established simultaneously, then a reliable FIX is obtained. A FIX is one's position in line on the water. This is often difficult to ascertain from a kayak. Transits are rarely available

when needed. However, an intelligent glance at the chart will often show that if a suitable back mark can be found that is visible over a wide range of bearings, an assortment of front marks are often available.



A transit of two features and a bearing of another single feature chosen because it is roughly at right angles to your transit line gives a useful fix, particularly if, as suggested above, the bearing of the transit is used to check the total compass error, and this is then applied to the second bearing. This is shown in the adjoining figure If the transit is 080 degree on the chart but 085 degree by compass, then the total compass error is 5 degree W. Hence, if the bearing of the individual object is 162 degree by compass its, TRUE bearing is actually 157 degree.



Visual compass bearings of two or more objects, carefully taken, can give a reasonable fix but it is best to take at least three. This is what is involved in plotting one of these bearings - that of the church in the adjoining figure - on the chart. Assume the reading from the hand bearing compass is 073 degree N. Because we know the variation is 7 degree W the True Bearing is 066 degree. Using parallel rules draw 066 degree to seaward from the church. Note the time of observation at the end of this line (1521). Repeat this process with the other two objects. If all three bearings a.re totally accurate (a rare event) the position lines will all intersect. Usually they form a small triangle - known as a cocked hat. The size of this cocked hat is a fair indication of the accuracy of your fixes in that if it is large then one or more of the bearings has to be out or incorrectly plotted. This is why it is important to not only take three bearings,, but also to choose features that allow for their position lines to provide for a good. cut, that is, at a sufficiently large angle.

If a cocked hat is of a reasonably small size then a fix is taken at its centre.

Of course, completing this plotting on the deck of your kayak means you can only do so on a calm day - but it remains a useful exercise in practical navigation none the less. There are other methods of securing a fix at sea. As these involve the use of special instruments like range-finders, ships logs and sextants they are of little practical value to the kayaker. Whenever paddling along a coast within sight of land or prominent features you should continually and consciously make every effort to judge your best position in relation to these features. This assists with deducing the effects of tide and wind on you and your party as you are underway. Personally, I prefer a topographical map on my deck with supplementary information on tides also available. Such maps will not only show many of the coastal features depicted on a chart but will also show greater detail of beaches, cliffs, roads, villages, telephones, hotels, pubs and camp sites. Farms, not shown on charts, are where you should get permission to camp and even perhaps get fresh milk. It may be worth while transposing nautical details such as navigational buoys onto your ‘topo’ (topographical map) - but frankly, I rarely bother.

PLOTTING A POSITION

There are various ways of marking on a chart your position once you have a good idea of it. We have already seen, how by the use of transits, fixes and position lines, we end up by plotting a position. Let us, for a moment, look at how, given that we are given a position, we locate this on the chart.

Latitude and Longitude is, as you know, expressed in degrees and minutes.

For example, Lat = 50 degree 31' N Long = 04 degree 05' W

When using large scale charts then we go onto express Lat and Long in not only degrees and minutes but also in seconds.

For example, Lat = 50 degree 31' 24" N Long == 04 degree 05' 54" W

On smaller scale charts Lat and Long is often expressed in degrees, and tenths of a minute.

For example Lat = 50 degree 31 '.4 N Long = 04 degree 05 '.9 W

Notice that when expressing position in tenths of a minute, the minute sign (') come BEFORE the decimal point.

PARALLEL RULES TO PLOT A POSITION

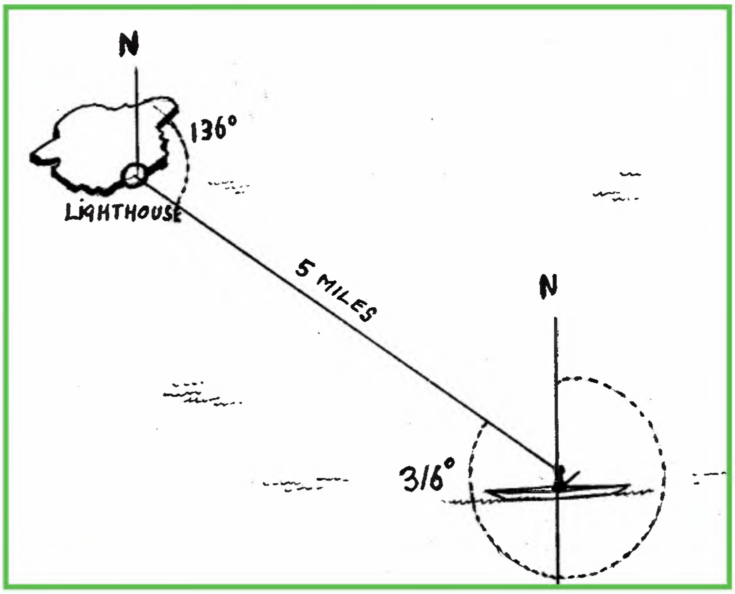
Simply aline your Rule to the required parallel of latitude by placing it on the nearest degree and minute and moving the top rule to line up exactly with the required second, close up the parallels and lightly pencil in a line. Do the same using the longitude scale at the bottom of the chart so that the pencil lines meet. At this junction you have plotted the lat. and long. at the edges of the chart. Using dividers, now measure off, to plot the print on the chart itself.

DOUGLAS PROTRACTOR

First place top edge of the protractor on the required graduation of latitude. Align one of the vertical lines on the protractor exactly with a meridian drawn on the chart or with a latitude graduation scale. With your pencil now over the precise latitude draw a short line. Do the same over the longitude scale. Now using dividers, as with parallel rules, measure off to plot the point on the chart.

BEARING AND RANGE

Although quoting a latitude and longitude is the most accurate method of expressing a position, another method exists, that of describing a position by means of a bearing (direction) and range (distance) OF or FROM a fixed point.



In the figure on this page, the kayak can describe its position as EITHER bearing 136 degree T, distance 5 miles FROM lighthouse OR WITH lighthouse bearing 316 degree T, distance of 5 miles.

You will notice that 316 degree is the reciprocal of 136 degree. The reciprocal of a direction expressed in 3-figure notation is that direction plus or minus 180 degree.

Because there are two ways of expressing the same thing and the clear expression of a position is of the utmost importance, both in plotting and expressing a position by this method, you MUST always be absolutely sure whether the bearing is OF or FROM the point of reference. If you were in distress requiring assistance and expressed your position carelessly, your rescuers in the above illustration could well be searching for you five miles on the other side of the island, - ten miles away from you actual position. Always give your bearings when establishing your position **from** a point, particularly when requesting emergency (MAYDAY) assistance.

ALLOWING FOR TIDAL EFFECTS ON A COURSE

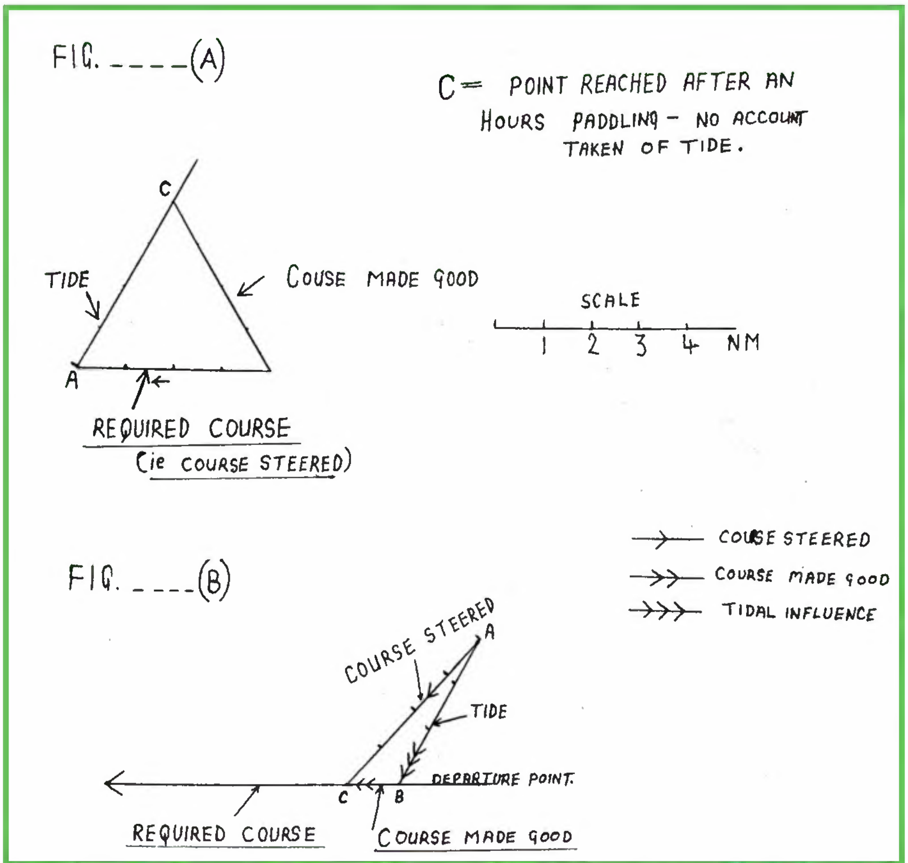
If you simply set a compass course and then set off without giving any consideration to effects of tide, then it will not be long before you realise that your destination is not going to be arrived at without a fairly drastic alteration to your course. On the other hand, you may arrive alright but get there very early - you have enjoyed a following tide. You may get within a few miles of your destination only to find that, despite paddling with extra effort, you are making painfully slow progress and eventually arrive quite worn out. You have been paddling against the tide.

More often we tend to paddle across the tides rather than with them when we undertake long crossings and my example looks at this. When coastal paddling it makes sense to go with the tide throughout your journey, using adverse tides as an opportunity to remain on land to sleep - wash clothes, repair equipment etc., anything but paddle against them. After all, given that your cruising speed is less than 4 knots and many of our tides on springs can reach between two and three knots, you can clearly see you are going to expend a lot of energy for a short distance.

So how do we actually make allowance for tidal flow? Let me demonstrate by using an example in which a 3 kn tide is flowing against a kayak being paddled at 4 kn. Clearly after an hour our kayaker has achieved only one nautical mile over the ground. Stay in your tent.

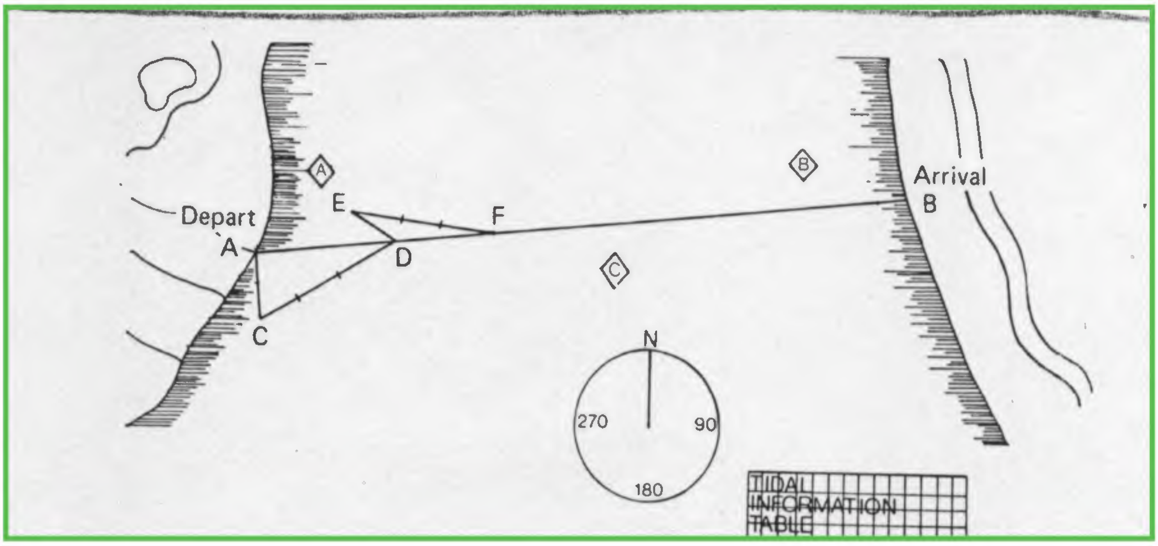
If the tide is flowing from the right or left, then we need to head up to the right or left to counteract. We are, in effect, using a parallelogram of forces. Let me illustrate.

In figure (A) in the drawings on this page, the paddler is experiencing a 3 knot tide from the NE as he/she is paddling directly westward at 4 knots. Remember we call tides flowing from the NE, SW tides - as opposed to winds which are given direction as determined from where they blow. A NE wind actually blows from the NE. Just thought I would remind you of this.



In figure (B) we have now taken account, of tidal influence - though with a NE 3 kn tide pushing the kayaker almost backwards and the kayaker only making 4 kn, after an hour, there has been a little over one nautical mile gained over the required course. In other words the kayaker has had to face almost right up into the on-coming tide and effectively perform a ferry glide. The method used to calculate the course to steer is simple. Using vector lines - i.e. lines with a scale showing the force of either tide or paddling power, you first show a vector drawn at the departure point to demonstrate the tidal force and direction, that is NE at 3 kn. From the end of this vector - 'A' draw a vector depicting your speed of 4 kn so that it crosses the required, course. This is the course to steer in order to compensate for the tide. After an hours paddling you will have made something over 1 N.M. to arrive at 'C'.

PLOTTING A COURSE



Let us assume that you wish to cross an open area of water which is 20 Nautical Miles wide.
Draw a line from your point of departure. A, to your point of arrival B. We have already determined that it is 20 N.M. long. Next decide on your estimated speed over the water, i.e. the speed at which you paddle. A strong group should be able to maintain a speed of between 3 and 4 knots. For the sake of this exercise we will agree on a speed of 3 knots.

FIRST HOUR.
Close to your departure point you will see an ‘ A’ within a diamond. By reference to column A on the tidal information table you will find, for the sake of this example, that the tide flows 180 degree at 2 knots Spring and I knot Neaps. As we are, again for the sake of example, half way in time between Springs and Neaps we must extrapolate to determine that the tide is running at 1.5 knots. Using your parallel rules draw a line from departure point ‘A’ in the direction of 180 degree. Now set a pair of dividers by using the scale at the SIDE of the chart, i.e. the latitude scale. (The latitude scale of the Mercator's chart is used to measure distances. Because the scale varies on the chart, particularly large scale charts, the scale of latitude which is abreast of your area of operation is the one to be measured). In this case set the dividers at 1.5 N.M. and mark the spot along this line to give the line AC.

Take a pair of dividers, space them to the scale of 3 N.M. (estimated speed per hour). Put one point on ‘C’ and where the other point crosses the line AB make the mark ‘D’. The direction of line CD is now determined by use of the parallel rules and the compass rose. We find that it is 45 degree. This is the True bearing we must steer from point ‘A’ to arrive at point ‘D’ one hour later.

SECOND HOUR.
Again from ‘A’ in the diamond we discover that the tide has now changed for the second hour out and is running at 1 knot in direction of 315 degree. From point ‘D’ draw a vector line in direction of 315 degree, I N.M. in length as previously described to give the line DE. Using the dividers draw a line 3 N.M. long to cross AB at ‘F’. The line EF represents the. True bearing to steer and the point ‘F’ is the point reached after the second hour. This procedure is repeated until you reach your destination at point B. Remember to use the different as they appear in the area of your calculations. The calculations show the trip should take seven hours. To avoid having to remember the different compass headings hour by hour, add the seven headings up and divide by seven. This will give an average bearing which, all things being favourable, should take you to your arrival point B.

An alternative method of plotting a course to steer exists and some say it is more reliable. This method consists of vectoring in all the tidal influences for the simulated period of your journey (crossing) from point of departure ‘A’ to destination ‘B’. To determine how many hours worth of vectors to plot, you require three pieces of information, viz.

1. Your estimated paddling speed
2. The actual distance from ‘A’ to ‘B’ and
3. An understanding of the overall influence of the tide over your journey; in other words, how much might it speed you up or slow you down. This is gauged by looking up the speed and direction of the tides at the appropriate hours before/after High Water (HW) in the Tidal Stream Atlas or using the Tidal Diamonds as previously described.

I will plot my course to steer across the 18 NM of open water at average paddling speed of 3.5 knots.

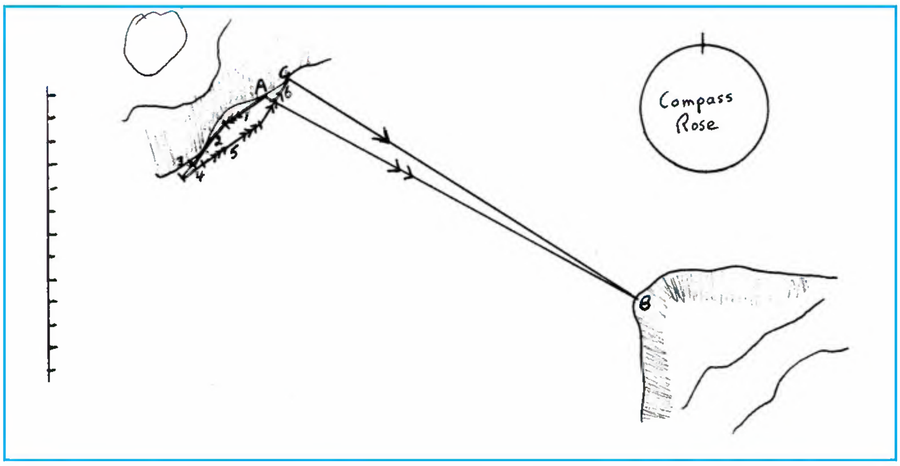
First I determine the date of departure. I then refer to the Tide Tables for this date for the nearest area/port of my crossing. From these I learn that HW is 1430 hrs BST (British Summer Time) and LW is at 2055. I also learn that I shall be three days away from Spring Tides.

Now you should assemble all this data. It is certainly a good plan to have it written down so that it is easily available to once underway (e.g. black waterproof ink on white fablon stuck to deck).
Here is what it should look like:
Date of departure................
Now note the hour by hour tidal activity:

TIME B.S.T.	HRS BEFORE/ AFTER HW	SPEED OF TIDE (KNOTS)	DIRECTION OF TIDE °T
1030	4 hrs Before	2.3	240°
1130	3 hrs Before	2.6	220°
1230	2 hrs Before	1.0	218°
1330	1 hr Before	1.0	035°
1430	HW	3.0	040°
1530	1 hr After	2.6	025°

Departure time = 1030 hrs
Time HW = 1430 hrs
Time LW = 2055 hrs
State of tide = Springs minus 3 days
Magnectic Variation = 3°W
Distance to destination = 18 NM
Estimated time for crossing = 6 hrs.

Now we have to plot this course on the chart

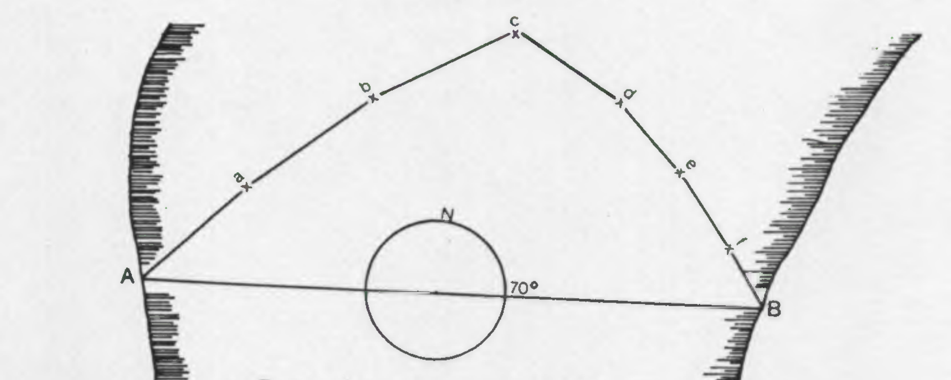


Remember, we are not considering wind strength and direction, nor have we planned any delays for such as comfort stops, meal breaks or busy shipping lanes. (Take it from me, crossing a shipping lane on the English Channel on a bad day is rather like crossing a busy motorway with a pram). Because of these 'unknowns' it is more than just useful to carry with you the details I am outlining right here so that you can refer to them when all is becoming hazy (i.e. you're lost!)

On the day you are going to have to make allowances for wind - leeway. If the wind is behind you then great, - you will make good time, - maybe even put a sail up. If though, as is normally the case the wind is coming from the side, you are going to have to alter course to head up into it slightly in order to compensate.

A final tip. As you start to identify your actual destination - for example, I am looking for the wide long beach at Wissant on the French Coast - I alter course a little more into the tide - and wind if it is blowing hard- so that my final approach is made with the tide and/or wind assisting me.

Another method of navigating open waters that I have favoured consists of simply plotting the tidal influence over your proposed route so that for the first half of the route the tide is running one way and at the halfway point it changes to sweep the other. This is really making the best use of tides when you are forced to paddle across them for any duration. It is certainly better than paddling constantly into a tide to stay on course as I effectively did on the return trip across the English Channel in my example before. If you are going to rely on the tide changing at a convenient time during your voyage so that it sweeps you back on course to bring your neatly into your destination, then of course you are going to have to determine your time of departure to suit the tides rather than your own convenience. 'Tide and Time wait for no man' - or woman for that matter !!



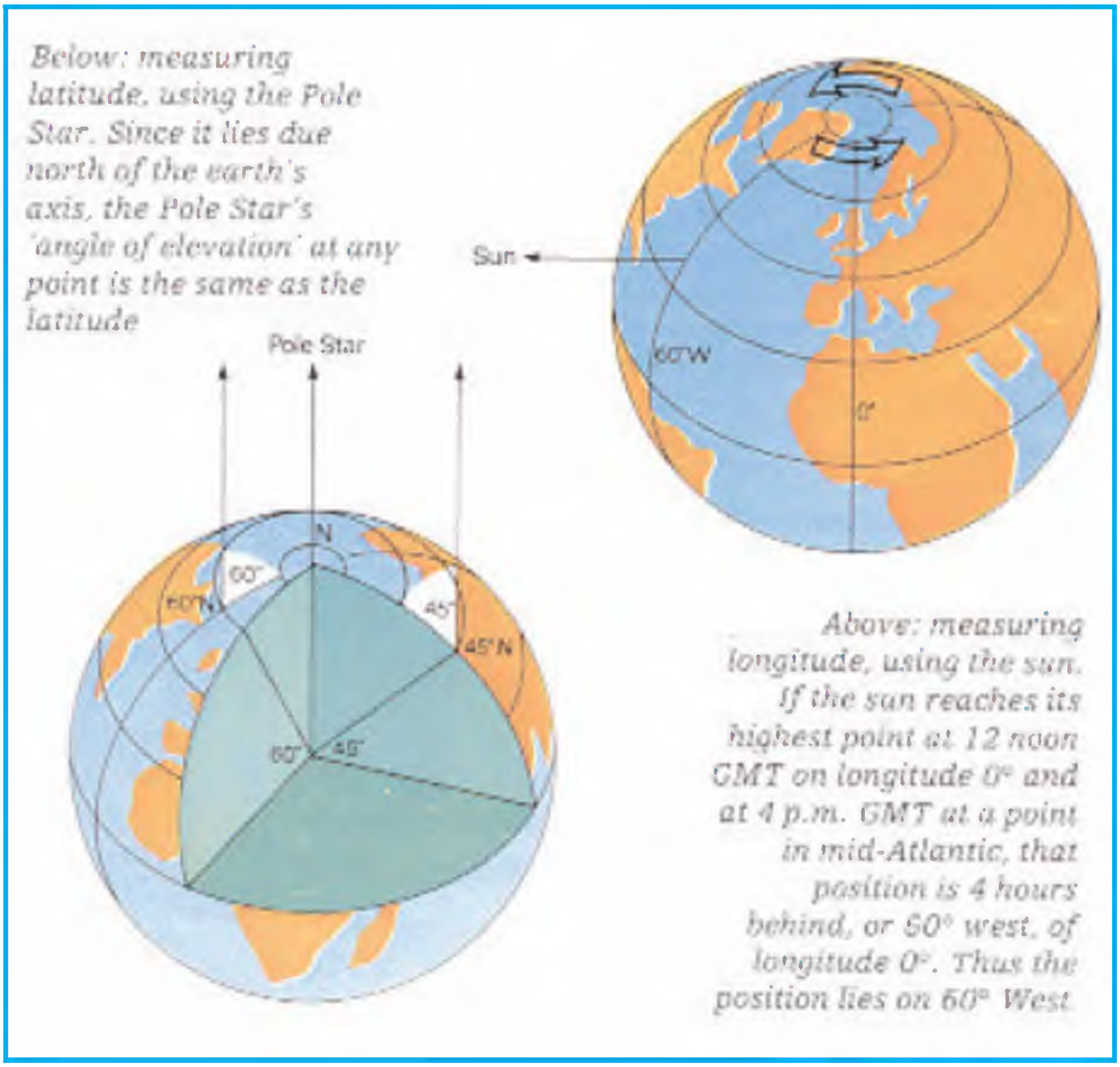
Each point represents where you will be if you paddle at 3 knots on 70°
By good fortune in this case the tide sweeps you nicely into arrival point B.

COCONUT NAVIGATION

In answer to a suggestion that 'Simple Navigation' was far too complicated! The idea that the early Polynesians used to navigate by means of a coconut was brought to mind. The coconut has often been referred to as the most important item in the everyday life of the islanders, because it supplied food, drink, linen-clothing, rope - you name it, there wasn't much the coconut couldn't do. Amazingly it served as a 'hand bearing compass'. The way it worked was to cut a coconut into a three-quarter section in such a way that if you filled it with water you obtain the level to look at the skies. Then, by putting holes in it on the opposite side, one for winter and one for summer, you would now have the ability to know on what latitude you were at any time.

The Polynesians living with nature, realised that the sun moved about 23 degrees North in the winter and come down 23 degrees South in the summer. Now in view of this common knowledge, the islander navigator suggested that the angle in the middle of winter, would be low on the horizon whilst it would be high in the summer. Consequently, by boring holes into a coconut, it was possible to have a hole for both winter and summer (i.e. the highest and lowest holes). Also two other holes depicting the 'spring and autumn', if that is what you like to call the inbetween seasons. It seems that the early Polynesians appreciated that the sun was at its highest point at midday. Perhaps by long use or by the same instinct pigeons have, they were able to assume some sort of position of the Earth's surface that perhaps we are all aware of in one way or the other. Now anyone knows the difference between summer and winter. Therefore, some realisation about the globe must have been instilled in early thinking.

The angle you take by 'looking through' is actually a form of latitude. If you read the early bibliography about the Polynesians, you will find that they navigated on the principle of running along a latitude. When they knew they were in the right longitude of the destination they would turn North or South and run down or up to the destination. This is what we are told and it makes a lot of sense. Europeans used to run the latitude when coming to Australia from the direction of the Cape of Good Hope - 'Running down the Westerlies', they called it. The idea was to keep on the same westerly latitude until time or dead reckoning told you to go North to enter Port Philip etc., or around the island of Tasmania, then turn North to the east Coast. All the wrecks on the West Coast of Tasmania; West Australia and King Island point out the fact that 'running down the westerlies; as it was known could be a hazardous business. Perhaps a coconut may have kept ships on a better latitude, who knows? Certainly the Polynesians seem to be able to run down or along their latitudes better or as good as we could !



Below: measuring latitude, using the Pole Star. Since it lies due north of the earth's axis, the Pole Star's 'angle of elevation' at any point is the same as the latitude

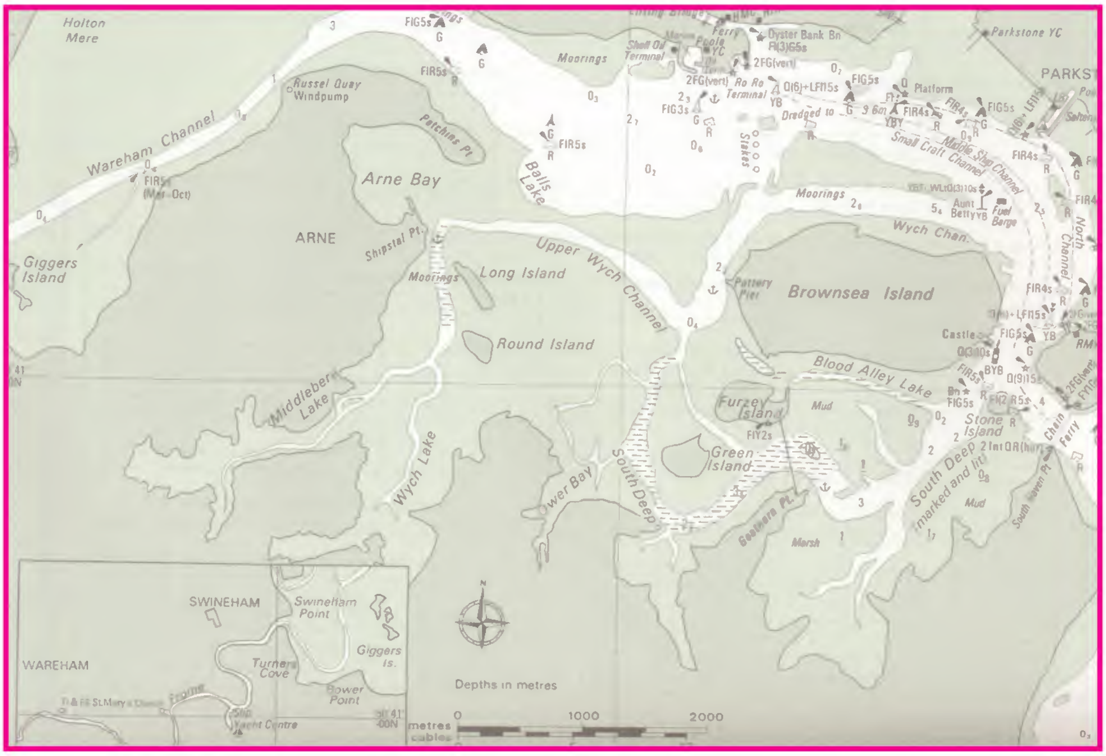
Above: measuring longitude, using the sun. If the sun reaches its highest point at 12 noon GMT on longitude 0° and at 4 p.m. GMT at a point in mid-Atlantic, that position is 4 hours behind, or 60° west, of longitude 0°. Thus the position lies on 60° West

CHAPTER SEVEN

CHARTS AND BUOYAGE

An ordnance survey map is familiar to us all. A similar detailed mapping of the sea is called a Chart. Charts are made on various scales, from one sheet covering most of the world to a similar sheet covering one small harbour, (known as a harbour plan). Charts are made according to a mathematical projection, that is to say, as the Earth's surface is curved it can only be shown upon a flat surface by projecting it, and this involves distorting it in some way. There are basically two different types of navigational charts issued by the Admiralty, the difference being in the method of projection. These two projections are called the Mercator and the Gnomic projections, the latter being used for large scale charts covering small areas. The Admiralty publish a chart catalogue covering the whole of the world's surface and listing the charts covering the various areas.
The charts can be roughly divided into three main groups:-
(1) general charts on a small scale covering large area
(2) coastal charts of larger scale, and
(3) detailed charts of harbours and estuaries, etc.

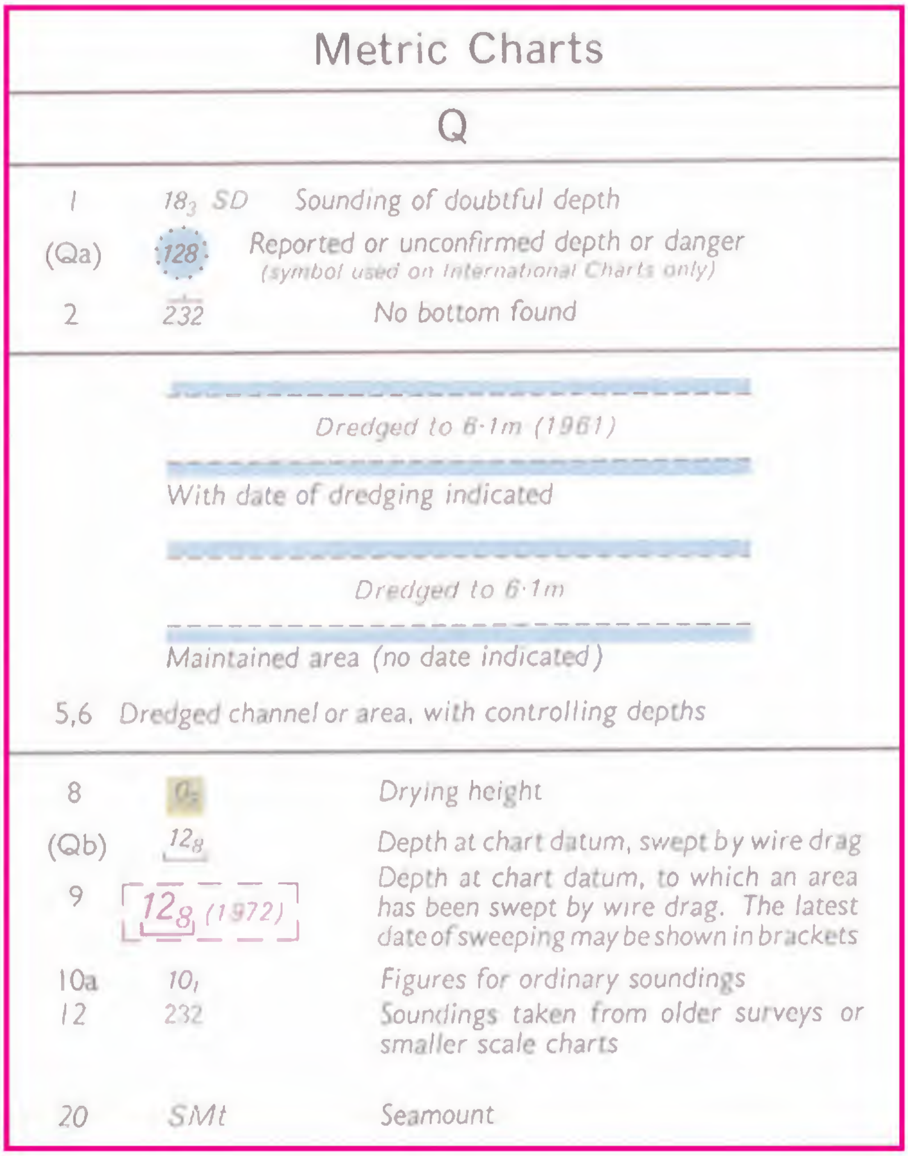
A 'home' section of this chart catalogue covering the British Isles and the NW coast of Europe as far as the Kiel Canal is issued separately. Each chart is known by a name and number and it is wise to always quote them both when ordering. Approximately 4,000 British Admiralty charts are published to span the world. Various other specialised charts such as magnetic variation, track charts and tidal stream atlases are also available. Most large chandlers stock a selection of charts and will be able to order whatever they do not stock. British Admiralty charts have been republished with depths and heights in metres including all the charts for home waters.



On these charts extensive use is made of colour, an invaluable aid for quick reference. The nautical mile and its relation to the Cable are unaltered. Ten cables still equals one sea (or- nautical) mile. The Admiralty, however, have adopted a new length for the Nautical Mile of 6,976.115 feet, and this is equivalent to 1,852 metres. This small change from 6,080 feet makes no practical difference as far as we are concerned.

INFORMATION FROM CHARTS

The following can be discovered from studying a good Chart :-


Metric Charts

Q

1	18_3 SD	Sounding of doubtful depth
(Qa)	128	Reported or unconfirmed depth or danger (symbol used on International Charts only)
2	232	No bottom found

Dredged to 6·1m (1961)

With date of dredging indicated

Dredged to 6·1m

Maintained area (no date indicated)

5,6 Dredged channel or area, with controlling depths

8		Drying height
(Qb)	12_8	Depth at chart datum, swept by wire drag
9	12_8 (1972)	Depth at chart datum, to which an area has been swept by wire drag. The latest date of sweeping may be shown in brackets
10a	10_1	Figures for ordinary soundings
12	232	Soundings taken from older surveys or smaller scale charts
20	SMt	Seamount

1. Land features. Only the features that are going to be of any use to the navigator are shown. For example, towers, church spires, hills etc.

2. Light houses. Light houses along a particular stretch of coast-line all have different characteristics so that one may not be confused with another.

3. Depth. All depths are given below Chart Datum, and the units are stated under the title. The legend 'DEPTHS IN METRES' is printed in colour outside the top and bottom borders of the chart. In places where there is no appreciable tide, depths are given below sea level. Depths of more than 20 metres are always given in whole metres, whereas depths of less than 20 metres are given in metres and decimetres, e.g. 5_3 which means 5.3 metres.

4. Datum. As has already been explained, the sea rises and falls, therefore, depth is not constant, hence Chart Datum. .

5. Depth Contours are lines joining points of equal depth. (Called "Fathom lines' on older charts).

6. Heights. Heights other than drying heights are. given in metres above M.H.W.S. (mean high water springs), except in places where there is no appreciable tide, where such heights are referred to sea level. Drying heights are given in metres and decimetres above Chart Datum and under-lined thus $\underline{1}6$ $\underline{0}6$ etc.

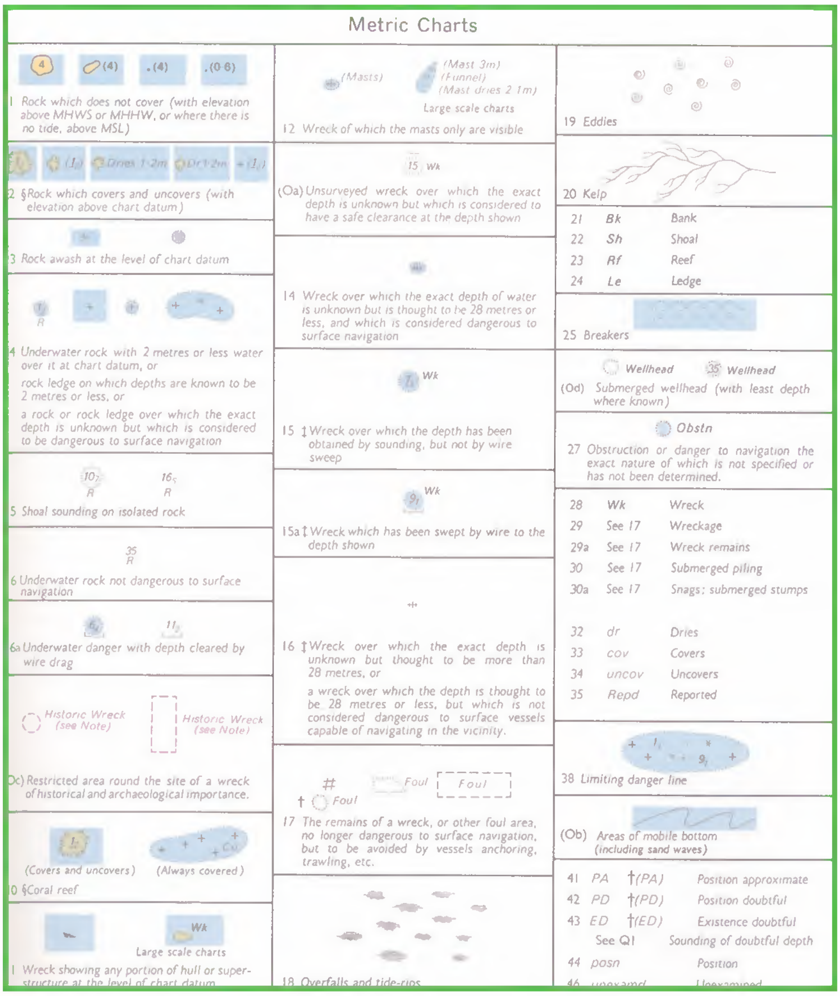
7. Danger. Foul ground for example remains of wreck or other debris where it would be unwise to anchor.

8. Type of sea bed or bottom.

9. Tints and colours. The land tint is buff and drying areas are green. The 10 metre contour is edged on the inside with a narrow blue ribbon, and all sea areas contained within the 5 metre contour are blue.

10. Chart Symbols.
For a full understanding of all symbols used in British Admiralty Charts, reference should be made to Admiralty Chart No. 5011 now published in book form. This gives full details of every symbol and abbreviation used and should be included in the equipment of everyone who takes their navigation seriously.

11. Tidal stream and current
information. A limited amount of information on tidal streams is shown on a chart. There are two ways of showing these streams:- (i) by arrows which show the general direction in which the stream normally sets and sometimes also gives its rate in knots. An arrow indicating ebb stream is shown thus: $\longrightarrow$
and one showing flood is shown thus: $\longleftarrow\!\!/\!/\!/$
(ii) By diamond shapes ⟨A⟩ with a letter within. By referring to a table on the chart, under the column headed by the letter found in the diamond, you will find the compass heading and speed of the tide for each hour before and after high water. Two readings are recorded. The larger of the two being spring tides and the lesser one being neap tides.



12. Compass Rose. This is a compass drawn on a chart. They are drawn True 0 to 360 very large and clear with a small line with half an arrow head , thus
reaching out from the centre of the rose pointing to the magnetic north. The amount of annual variation with the year of publication will be shown, together with the annual rate of change..


Paddling on the Hudson by Manhattan

BUOYS AND BUOYAGE SYSTEMS

In order to mark the limits of channels between shoals and sandbanks, and to mark isolated dangers such as rocks, wrecks or similar obstructions to navigation, buoys are moored to the sea bottom to assist the navigator. These buoys may, or may not, be fitted with characteristic lights and/or fog signals. Their shape, colour, topmarks (if any) and other characteristics are not indiscriminate but are determined by the particular buoyage system adopted by the government of the maritime nation responsible for maintaining the buoys. Until very recently there was no unified system of buoyage adopted by the maritime nations of the world; in European waters two general systems, known respectively as the 'Lateral' and "Cardinal' systems were in use, but a different system again was used in North American waters and in various other parts of the world.

However, for several years the International Association of Lighthouse Authorities (IALA) has been working on a the introduction of a unified Maritime Buoyage System which would combine features of the old system with a new for introduction, initially throughout North-West European waters, and then in other areas of the world. This is now in place.

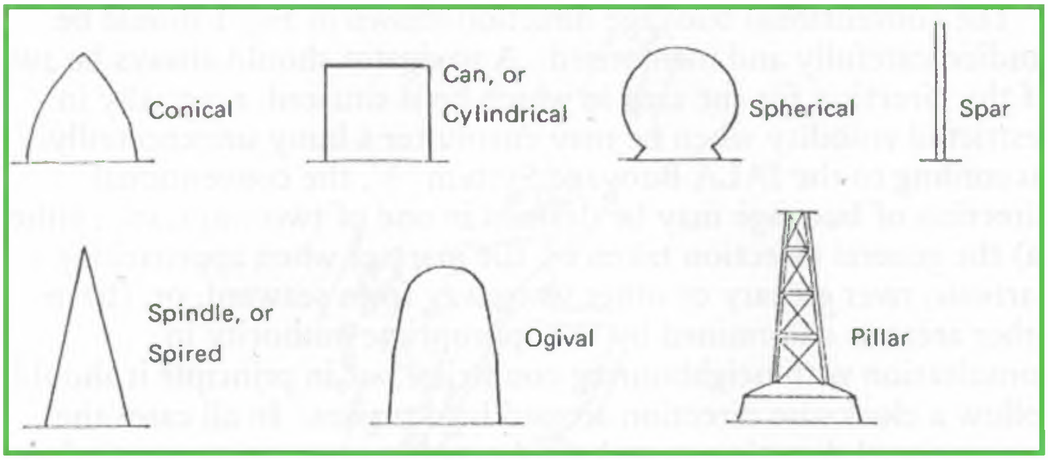
Concurrently with the introduction of the new IALA Buoyage System, a "conventional buoyage direction' around the coast of the United Kingdom will replace the present, practice whereby buoyage is

CONVENTIONAL BUOYAGE DIRECTION UNITED KINGDOM AND REPUBLIC OF IRELAND.

established with regard to the direction of the main stream of flood tide. The diagram above shows how this conventional buoyage direction will operate. So far as the coast of the United Kingdom is concerned, the only alteration of any significance is the reversal of the present direction of buoyage on the East coasts of Scotland and England north of Orfordness. The practice whereby the direction of buoyage in rivers and estuaries is from seaward inward has remained unchanged.

The conventional buoyage direction shown on the previous page should be studied carefully and memorised. A navigator should always be aware of the direction for the area in which he is situated, especially in restricted visibility when he may encounter a buoy unexpectedly. According to the IALA Buoyage System "A', the conventional direction of buoyage may be defined in one of two ways, viz., either
(a) the general direction taken by the mariner when approaching a harbour, river estuary or other waterway from seaward; or,
(b) in other areas as determined by the appropriate authority in consultation with neighbouring countries, but in principle it should follow a clockwise direction around land masses. In all cases the conventional direction must be indicated in appropriate nautical documents (e.g.. Sailing Directions).

THE RECOGNITION OF BUOYS.
A mariner may recognise a buoy by day by (a) its shape, (b) its colour, and (c) its topmark (which may be a different shape from the buoy on which it is fitted). By night, if the buoy is a light-buoy, the ma.riner may recognise it by (a) the colour of its light (b) the characteristic of its light (flash, group-flash, occulting, etc., as for other navigational lights), or (c) by its aural signal (bell or whistle). The seven main shapes used in buoyage systems are illustrated in figure 2. The colours may be red, green, yellow, white or black, used either singly or in combination. The top-marks fitted to buoys may be shaped conical, cylindrical (can) or spherical, and sometimes in the shape of a cross or diamond. Buoys may also be fitted with radar reflectors which should not be confused with top-marks. Fog signals fitted to certain buoys can be either a whistle or a bell. In most cases the sound is actuated only by the motion of the buoy in the sea, so that the signal may not be heard in calm weather. On navigational charts, buoys are indicated by a small drawing representing the shape of the buoy, the precise position being indicated by the small circle in the middle of the buoy's waterline. An abbreviation to indicate the colour of the buoy is printed underneath the symbol, and if the buoy is a light-buoy, the appropriate abbreviation for the light characteristic is printed to the right of the



symbol, although the period (5 sec., 10s and 15s) may not always be charted.
The symbol used to indicate the conventional buoyage direction where this is not immediately obvious is :

the size and orientation of this symbol will be varied to suit its situation on the chart, and the colour of this symbol will be magenta.

THE 1. A. L. A. UNIFORM MARITIME BUOYAGE SYSTEM 'A'.
This system applied to all fixed and floating marks (other than lighthouses, sector light, lightships and ‘lighthouse buoys') serving to indicate: -
(a) The lateral limits of navigable channels
(b) Natural dangers and other obstructions such as wrecks
(c) Other areas or features of importance to the mariner
(d) New dangers

The system of buoyage provides five types of marks which may be used in any combination as follows:-
(i) Lateral marks used in conjunction with the conventional direction of buoyage, generally used. for well-defined channels. These marks indicate the port and starboard sides of the route to be followed.
(ii) Cardinal marks, used in conjunction with the mariner's compass, to indicate where the mariner may find navigable water.
(iii) Isolated Danger marks indicating isolated dangers of limited size which have navigable water all round them.
(iv) Safe Water marks indicating that there is navigable water all round that position, e.g., mid-channel mark.
(v) Special marks not primarily intended to assist navigation but indicating an area or feature referred to in nautical documents.

THE LATERAL MARKS OF 1. A. L .A. BUOYAGE SYSTEM 'A'
Lateral marks are termed either 'Port Hand Marks' or 'Starboard Hand Marks'.
Port Hand means that side of a channel which is on the LEFT HAND of the mariner when he is proceeding in the same direction as the conventional direction of buoyage, or when ENTERING a harbour, river or estuary FROM SEAWARD.
Starboard Hand means that side of a channel which is on the RIGHT HAND of the mariner when he is proceeding in the same direction as the conventional direction of buoyage, or when ENTERING a harbour, river or estuary FROM SEAWARD.
Lateral marks are either can, conical, pillar or spar in shape, and either red or green in colour.

PORT HAND MARKS.....are always red in colour, and can either be can, pillar or spar in shape. If a top-mark is fitted, this will be a single red can, and if a light is fitted, this will always be red in colour although any rhythm may be used (flashing, group- flashing, quick flashing, long-flashing, isophase, occulting or group-occulting). Port hand marks should always be left on the mariner 's port hand when proceeding in the conventional direction of buoyage or when entering a harbour, river or estuary from seaward.
Note, however, that when proceeding seaward or against the conventional direction of buoyage, port hand marks should be left on the mariner's starboard hand.

STARBOARD HAND MARKS......are green (*Where, for exceptional reasons, an Authority considers that a green colour is not satisfactory, black may be used.*) in colour, and either conical, pillar or spar in shape. If a topmark is fitted, this will be a single green cone point up, and if a light is fitted this will always be green in colour although any rhythm may be used (flashing, group-flashing, quick-flashing, long-flashing, isophase, occulting or group-occulting). Starboard hand marks should always be left on the mariner's starboard hand when proceeding in the conventional direction of buoyage or when entering a harbour, river or estuary from seaward. Note, however, that when proceeding seaward or against the conventional direction of buoyage, starboard hand marks should be left on the mariner's port hand.Where port or starboard lateral marks do not rely upon can or conical buoys shapes for identification (i.e., where pillar or spar buoys or marks are used) they should, where practicable, carry the appropriate topmark. If marks at the sides of a channel are numbered or lettered, the numbering or lettering will follow the conventional direction of buoyage.

THE CARDINAL MARKS OF THE I. A. L. A. BUOYAGE SYSTEM “A”
Cardinal Marks may be used, for example:-
(a) To indicate that the deepest water in that area is on the named side of the mark
(b) To indicate the safe side on which to pass a danger
(c) To draw attention to a feature in a channel such as a bend, a junction, a bifurcation, or the end of a shoal.

A Cardinal Mark is named after the quadrant in which it is placed, and the four quadrants (North, East, South and West) are bounded by the true bearings NW-NE, NE-SE, SE-SW, and SW-NW, taken from the point of interest. The name of a cardinal mark indicates that it should be passed to the named side of the mark. The cardinal marks are illustrated on Page 218, which is self- explanatory, but the following notes will be helpful.

The double-cone topmark is the most important feature of every cardinal mark by day, and authorities are directed to make them as large as possible with a clear separation between the cones.

By night, the rhythm of the white flashing light is the most important feature of every cardinal mark and the IALA define certain of these rhythms as follows:-

VQF = Very Quick Flashing, i.e., a light flashing at the rate of either 120 or 100 flashes per minute.

QF = Quick Flashing, i.e., a light flashing at the rate of either 60 or 50 flashes per minute.

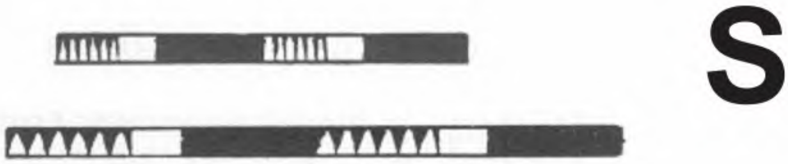
LF = Long Flash, i.e., a light appearance of not less than 2 seconds duration.

The characteristics of lights fitted to Cardinal Marks may be summarised as follows;-

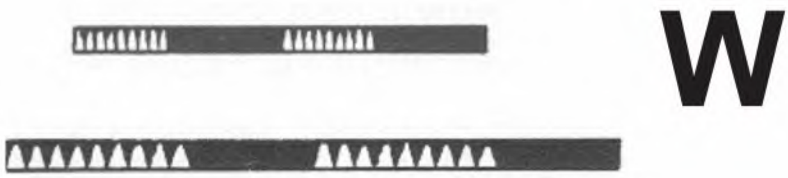
NORTH CARDINAL MARKS
Light (when fitted):-
Colour - WHITE
Rhythm - VQF or QF

EAST CARDINAL MARKS
Light (when fitted);-
Colour - WHITE
Rhythm - VQF (3) every 5 sec.
or QF(3) every 10 sec.

SOUTH CARDINAL MARKS
Light (when fitted):-
Colour - WHITE
Rhythm - VQF(6)+LF every 10 sec.
or QF(6)+LF every 15
sec.



WEST CARDINAL MARKS
Light (when fitted):-
Colour - WHITE
Rhythm - VQF(9) every 10 sec.
or QF(9) every 15 sec.



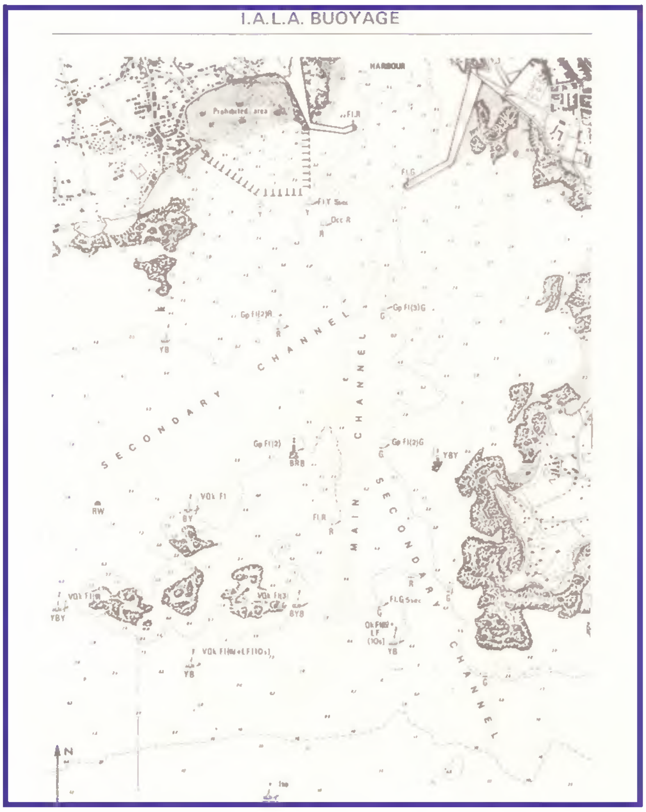
ISOLATED DANGER MARKS AND SAFE WATER MARKS.
An isolated danger mark is a mark erected on, or moored above, an isolated danger of limited size which has navigable water all round it. An isolated danger mark is pillar or spar in shape, coloured black with one or more broad horizontal red bands, and has a topmark consisting of two black spheres, one above the other. If a light is fitted, its colour will be white and its rhythm will be Group Flashing (2). The double sphere topmark is the most important feature of every isolated danger mark by day, and authorities are directed to make them as large as possible with a clear separation between the spheres.

Safe Water Marks serve to indicate that there is navigable water all round the mark; these include centre line marks and mid- channel marks. Such a mark may also be used as an alternative to a Cardinal or a Lateral Mark to indicate a landfall. Safe Water Marks are either spherical, pillar or spar in shape with red and white vertical stripes. Pillar or spar buoys must be fitted with a single red sphere topmark. If a light is fitted, its colour will be white and its rhythm will be either isophase, occulting, one long flash every 10 seconds or emitting the morse signal ‘A’.

SPECIAL MARKS AND THE MARKING OF NEW DANGERS.

Special Marks are marks no primarily intended to assist navigation but which indicate a special area or feature referred to in appropriate nautical documents (e.g.. Sailing Directions), for example:- (a) Spoil Ground Marks (a spoil ground is either an area where sewage pipe discharge into the sea, or where dredgers discharge their sludge)
(b) Military or Naval Exercise Zone Marks
(c) Cable or Pipe Line Marks
(d) Recreation Zone Marks
(e) Traffic Separation Marks where use of conventional channel marking may cause confusion
(f) Ocean Data Acquisition Systems (ODAS) Marks.

Special Marks may be any shape providing they do not conflict with navigational marks but they must be yellow in colour and the topmark (if fitted) must be a single yellow "X' shape. If a light is fitted it will be yellow in colour and may be of any rhythm other than those prescribed for Cardinal, Isolated Danger or Safe Water marks. Special Marks other than those described above many be established by the responsible administration to meet exceptional circumstances, but such marks will not. conflict with navigational marks and will be promulgated in appropriate nautical documents. The term 'New Danger' is used to describe newly discovered hazards not yet indicated in nautical documents. 'New Dangers’ include naturally occurring obstructions such as sandbanks or rocks, or man-made dangers such as wrecks. New Dangers will be marked with Cardinal or Isolated Danger marks in accordance with IALA Buoyage System 'A" but if the appropriate Authority considers the d.anger to be especially grave, at least one of the marks will be duplicated as soon as practicable, the duplicate mark being identical to its partner in all respects. The duplicate mark may be removed when the appropriate Authority is satisfied that the information concerning the new danger has been sufficiently promulgated.The chart and diagram on below which illustrate the application of the IALA Maritime Buoyage System 'A'.



BUOYS AS AIDS TO NAVIGATION.

For information concerning buoyage in any locality the best guide is the largest scale chart of the area. Details of buoys may be given in the 'Sailing Directions' (Pilot Books), but light-buoys are not mentioned in the 'Admiralty List of Light and Fog Signals', although some are included in the light list in the (Macmillan) Nautical Almanac. When trying to identify a buoy at sea, the shape should be considered more important than the colour, but it should be remembered that in poor visibility, topmarks, lights or radar reflectors may give a misleading impression of shape. Buoys are often discoloured by bird droppings, sometimes to the extent of obliterating the buoys' name or number, and even a black buoy can be so discoloured by gull guano as to be confusing at night.

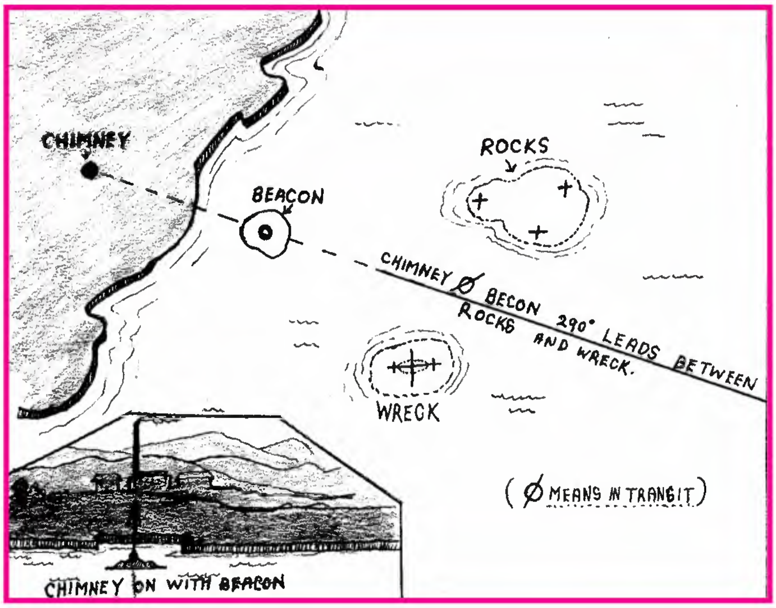
Navigators should always regard buoys as no more than aids or guides to navigation, and never rely implicitly upon them. Buoys, particularly those in exposed positions, are liable to drag their moorings and be out of their charted position. They can be sunk following a collision with a large vessel, and they can be removed without notice for overhaul. This is not to imply that buoys are of no value to the navigator, for places like the Thames Estuary would be well nigh impossible to navigate without them, and around the coasts of the United Kingdom, Trinity House provides a magnificent service in tending many thousands of buoys (as well as light-vessels, beacons and other navigational aids). But a navigator is nothing if he is not prudent, and if he can verify his position from fixed objects ashore, then he can navigate his buoyed channel with greater confidence. Always remember that it is possible to come up with a buoy when you are on a course at right angles (or any other angle) to the conventional direction of buoyage, and you must be prepared to deal with this situation.

BEACONS, LEADING MARKS AND CLEARING LINES

BEACONS

Another aid to navigation is the beacon, a fixed structure made of wood, metal or concrete which may be situated on a rock, on sandbanks or mudbanks. Beacons are primarily intended as daylight marks and because they are built on solid ground are generally more reliable than buoys. They are painted in various distinguishing colours and may be fitted with topmarks, but so far as possible their markings will comply with the IALA Buoyage System 'A'. A beacon would be shown on a small-scale chart simply as Bn., but on a large-scale chart more detail regarding the colour, shape and topmark of the beacon is given. Lighted beacons are normally shown by means of a light star and abbreviated light description. The legend ‘Bn’ and the appropriate topmark (if any) are added when the beacons themselves are of special significance (as leading marks, for example).

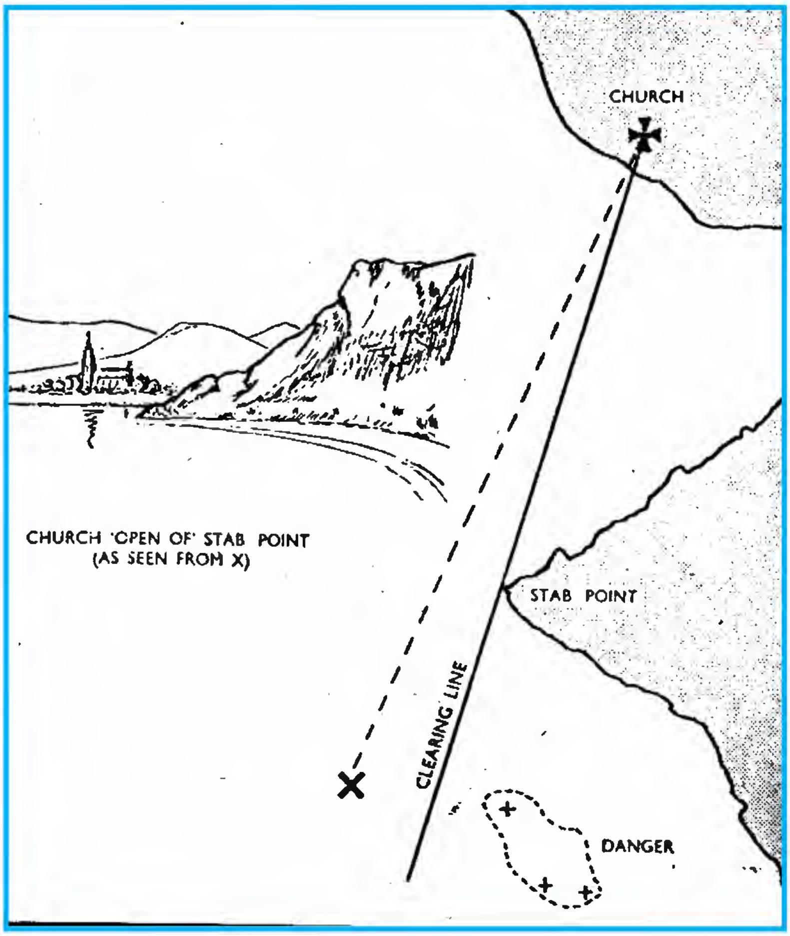
LEADING MARKS

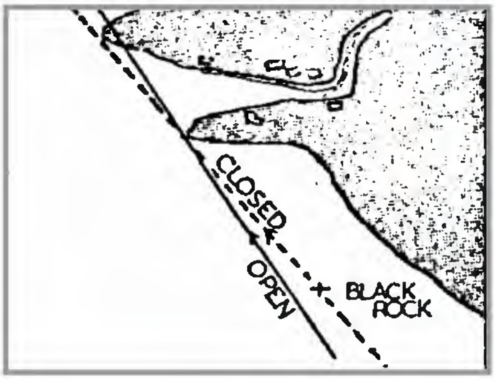


Just as navigational lights can be placed in line to lead a vessel into a harbour, so beacons or other conspicuous objects in line can serve as leading marks in daytime. Many harbour plans show two marks which, when kept in line (or 'in transit' as this is called), lead a vessel through a safe channel. These 'leading marks' are shown on a chart by a line through them projecting seaward called a 'leading' line. The adjacent diagram shows a leading line between rocks and a wreck when a beacon and a chimney are in transit. Note that the leading line drawn on the chart is partly solid and partly dotted - this signifies that the mariner should only remain on the line as far as the solid section. In order to follow a leading line a canoeist should steer to a position outside the area of danger where he has the leading marks in transit, and then steer towards them, adjusting his course as necessary to keep the front mark in line with the rear mark until clear of the danger area.

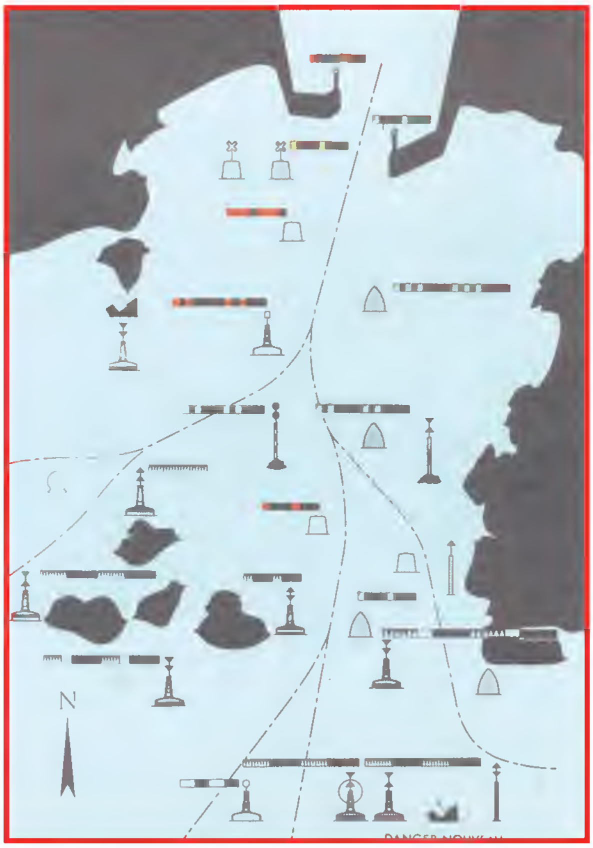
CLEARING LINES

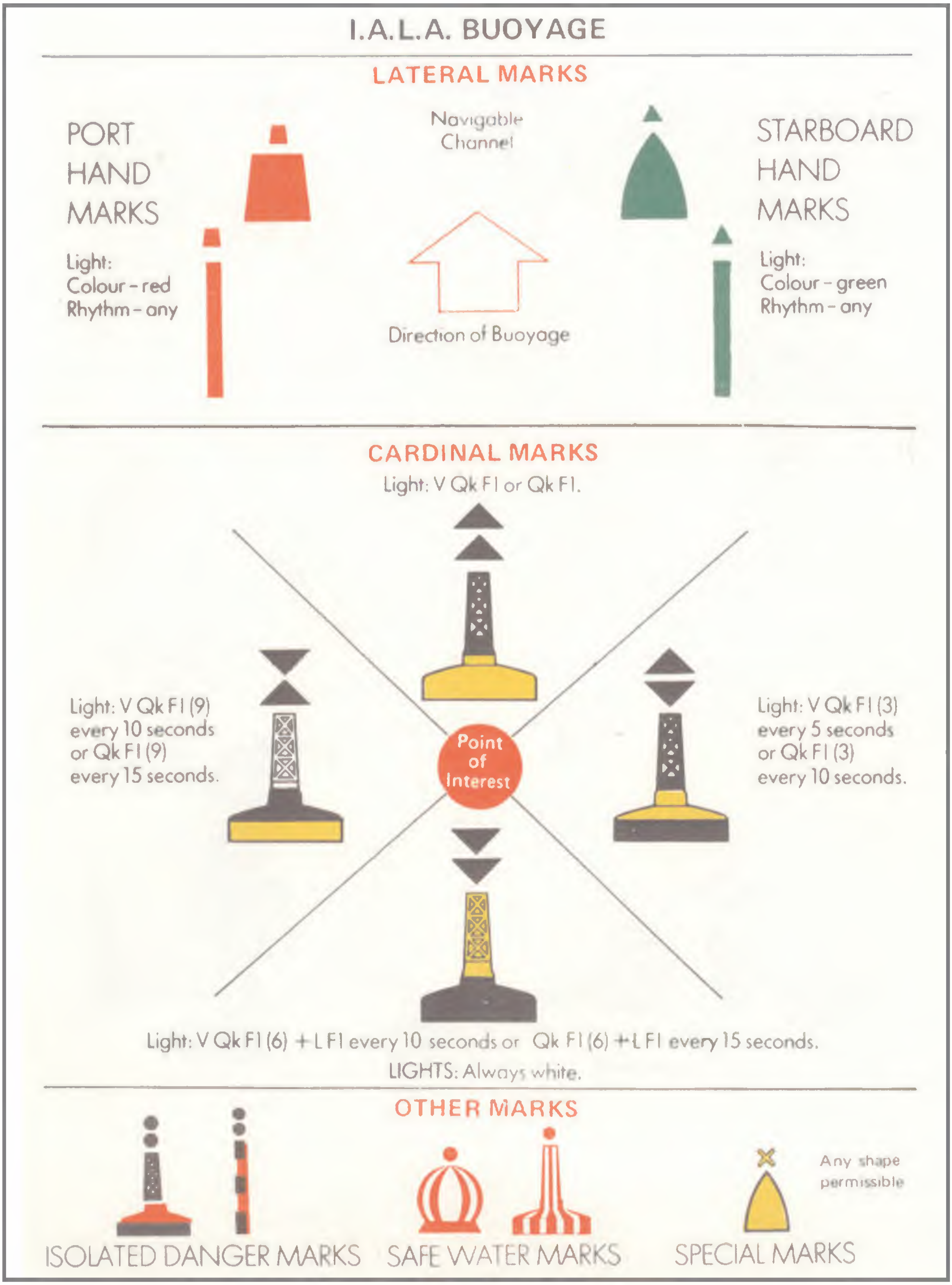
When a hidden danger lies in the approach to an anchorage or harbour, it will often be found that a 'clearing line' is drawn on the chart. This line leads clear of the danger and a canoeist must be in safe water if he keeps outside it, that is, when the marks are kept "open'. In the adjacent figure, the clearing marks are the church and Stab Point (i.e., the church must be "open' or visible behind Stab Point in order to clear the rocks south of Stab Point). In the figure below, it shows the difference between two headlands 'closed' (the nearer headland obscuring the more distant one), and 'open' (the distant headland visible beyond the nearer one).





It must never be forgotten that all bearings quoted on charts and in all navigational publications for leading lines and clearing marks are ALWAYS given as seen by an observer FROM SEAWARD, and that they are always TRUE BEARINGS, never Magnetic or Compass.




I.A.L.A. BUOYAGE
LATERAL MARKS
PORT HAND MARKS
Light:
Colour - red
Rhythm - any
Navigable Channel
Direction of Buoyage
STARBOARD HAND MARKS
Light:
Colour - green
Rhythm - any
CARDINAL MARKS
Light: V Qk Fl or Qk Fl.
Light: V Qk Fl (9) every 10 seconds or Qk Fl (9) every 15 seconds.
Point of Interest
Light: V Qk Fl (3) every 5 seconds or Qk Fl (3) every 10 seconds.
Light: V Qk Fl (6) + L Fl every 10 seconds or Qk Fl (6) + L Fl every 15 seconds.
LIGHTS: Always white.
OTHER MARKS
Any shape permissible
ISOLATED DANGER MARKS
SAFE WATER MARKS
SPECIAL MARKS