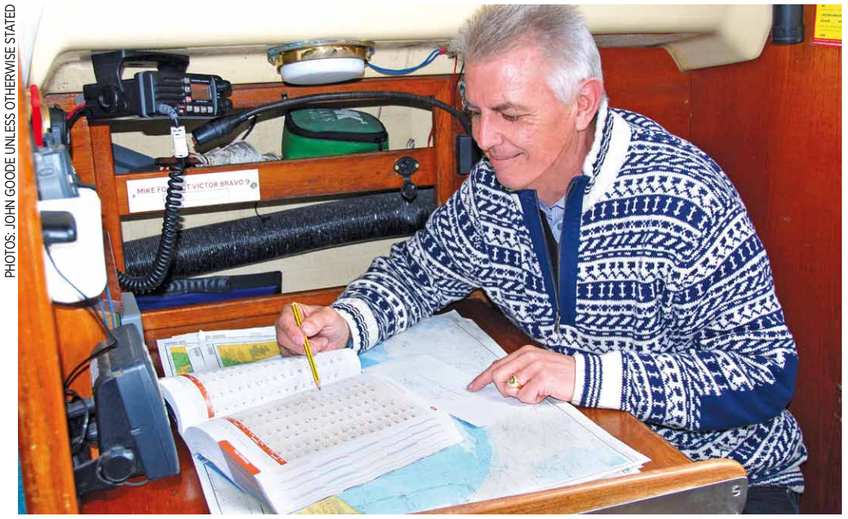
Ex-Merchant Navy officer and Fellow of the Royal Institute of Navigation, John Goode owned Southern Sailing School for 25 years and is an RYA examiner

How to work out tidal heights

If calculating tidal heights doesn't come easily, John Goode offers help with the sums and encourages you to use the results with confidence

PHOTOS: JOHN GOODE UNLESS OTHERWISE STATED



In practice, if reasonable care is taken we can expect an accuracy of at least one foot – or better

This gauge tells you the height of water over a marina sill, but would you trust your own calculations?

PHOTO: GRAHAM SNOOK

EXPERT ON BOARD

'If reasonable care is taken when working out tidal heights, we can expect an accuracy of at least one foot – or better'

The great thing about practical navigation is that we don't need to be red hot with numbers, or a computer genius, to get by.

Whether we favour traditional or electronic methods (or a mixture of both), what's wanted on a lightly manned yacht at sea is a grasp of basic principles and common sense in abundance.

This particularly applies when it comes to calculating tidal heights, where simply casting a knowledgeable eye over the tables to obtain a prediction that's accurate to within a metre or so is often quite sufficient. However, when more dependable accuracy is called for we really do need to have confidence in our calculations. If we haven't, we'll be restricted to 'playing it safe' by only going into shallow water near the top of a tide – or limiting our visits to easily entered (but often overcrowded) harbours that have well-marked, deep-water channels.

Probably the main reason for not trusting our tidal height predictions is the nagging doubt that we might get the sums wrong and end up like this

Nagging doubt

Probably the main reason for not trusting (or using to full advantage) our mid-tide predictions is the nagging doubt that we might get the sums wrong – especially if it means taking our keel anywhere near the bottom on the strength of them. For those to whom juggling with numbers doesn't come easily, the least interpolation we have to do the better, so hopefully what's shown over the following pages will both clarify a few basic concepts – and offer some alternative prediction methods that can reduce the risk of arithmetical error.

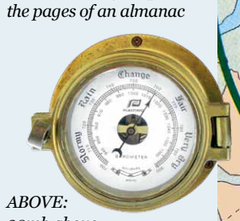
The more faith we have in our ability to predict the height of tide (above what's shown on the chart) at any stage of its rise or fall, the more interesting places we'll be able to visit – and the more fun we'll have.

Less pressure

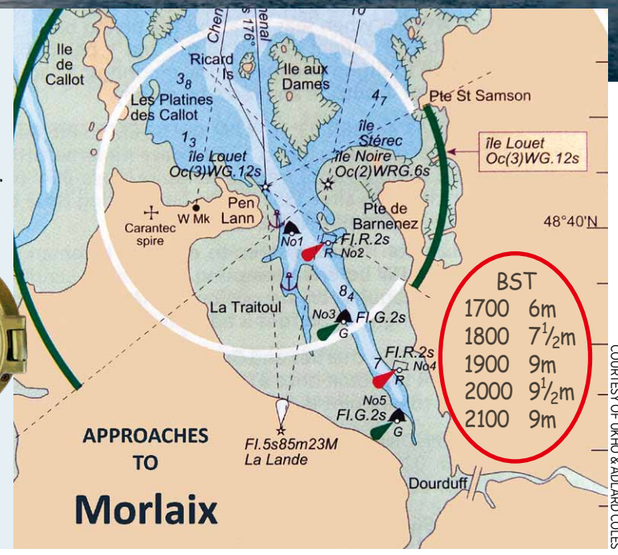
However, we don't just need to come up with theoretically accurate 'predictions'. We've also got to be aware of any phenomena that could affect them in practice. While the result of a storm surge or strong wind blowing for a long period into, or out of, an estuary isn't so readily calculated, one factor that we can easily allow for, but which is rarely taken into consideration, is abnormally high or low barometric pressure. For every millibar above the average pressure of 1013mb, charted depth will be reduced by 1cm – and raised by 1cm for every millibar below it.

Finally, I've found it reassuring over the years that in practice, if reasonable care is taken when working out tidal heights, we can expect an accuracy of at least one foot or better. So do try to trust and use them.

RIGHT: When the use of tidal heights is essential, it's good to have them where they can be seen at a glance. Pencilled on the chart or pilot book we're using is better than hunting for scraps of paper – or burrowing deep into the pages of an almanac



ABOVE: 30mb above or below the average barometric pressure of 1013mb can lower/raise depths by 0.3 metres



COURTESY OF UKHO & ADLARD COLES

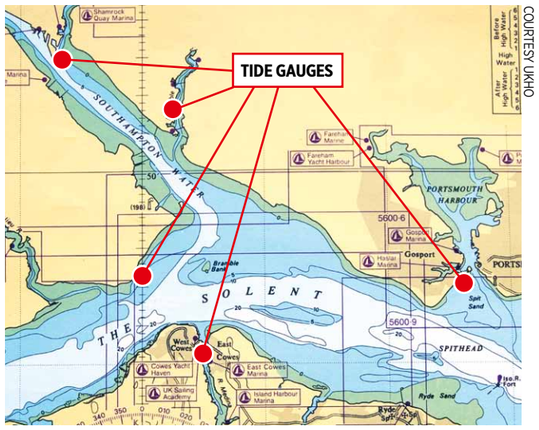
Tips to check and use your sums

1 Compare 'calculated' height with 'actual' height

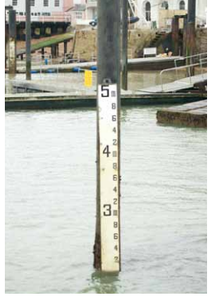
It's important to always bear in mind that no matter what the source of data, or method of calculation we use to obtain a tidal height prediction, it is just that – a prediction.

Whenever the opportunity arises, it's worth taking advantage of the many (charted) tide gauges around our shores. As well as being precise indicators of what effect any extremes of barometric pressure, or storm surges, are having on predicted tidal heights, they can also provide a very useful check on the accuracy of our own calculations.

Located near the entrances of most major harbours and some smaller ones (although at the latter they are increasingly missing or poorly maintained), they reliably indicate the actual height of tide above Chart Datum.



COURTESY UKHO

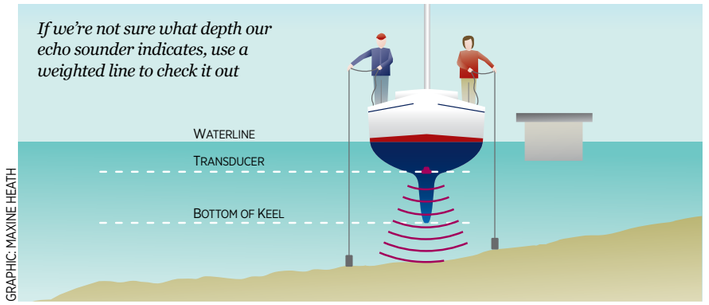


When we pass a tide gauge it can be useful to compare the (actual) height of tide above Chart Datum shown on the gauge with our own (calculated) tidal height prediction.

Any difference noted when we're near the gauge can then be applied to our calculated height for the surrounding area – which is especially good to know when heading inbound towards a harbour's shallower upper reaches

2 Check the calibration of the depth sounder's read-out

Before relying on a depth sounder's read-out, we first need to know how it has been calibrated. For some skippers (and most charter outfits), the sounder is often considered to be not much more than an anti-grounding device and is calibrated to read from the bottom of the keel. But because an overall depth reading can be used as a key navigational tool, it will be a lot more beneficial if, as shown below, the sounder's display is adjusted to read from the waterline.



If we're not sure what depth our echo sounder indicates, use a weighted line to check it out

GRAPHIC: MAXINE HEATH

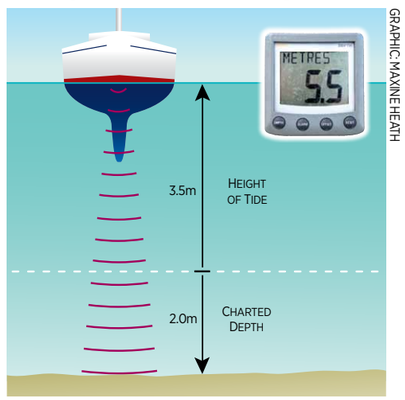
In case there's a sloping bottom, dip from both sides of the boat and use the average measurement to compare with the sounder's read-out

3 A good reason to adjust to waterline depth

Just one example of how using waterline depth can offer peace of mind is when – even in familiar local waters – the visibility deteriorates suddenly.

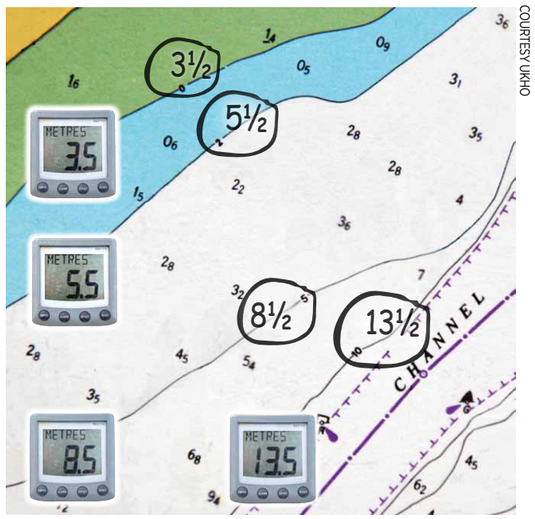
As shown (far right), all we need do is 'pencil' in the overall depth of water on the relevant contour lines (here it's 3.5 metres above CD).

Then, simply by maintaining our chosen depth on the sounder between contour lines (or tacking between them), we can safely keep clear of the main channel or close the shore to a depth that suits our draught.



GRAPHIC: MAXINE HEATH

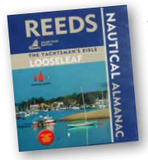
Without the added complication of allowing for a sounder's bottom-of-keel offset, a depth reading from the waterline can be a very useful navigational tool



COURTESY UKHO

Straightforward standard port

Standard ports are usually larger naval or commercial harbours that have their own comprehensive tide tables. By referencing these to their equally unique tidal curves and graphs, specific height and time data can be quickly and easily extracted without having to grapple with any interpolation.



The tidal data illustrated is reproduced from Reeds Nautical Almanac. *Although not shown here, it also includes special curves for places where HW anomalies occur. Based on the more defined time of LW, they are used exactly the same way.*

Extract times and heights of Low Water and High Water

This example uses the standard port of Milford Haven during a rising tide on the afternoon of 2 June – when tidal heights are about three-quarters of the way between the (higher) Springs and (lower) Neaps ranges. Note that all heights are above Chart Datum (below which all depths are shown on a chart) and that the time zone is UT (GMT in old money), to which one hour should be added if working in BST.

TIME ZONE (UT) For Summer Time add ONE hour in non-shaded areas

MILFORD HAVEN LAT 51°42'N LONG 5°03'W

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

Dates in red are SPRINGS Dates in blue are NEAPS

MAY				JUNE				JULY				AUGUST			
Time	m	Time	m	Time	m	Time	m	Time	m	Time	m	Time	m	Time	m
1 0459	6.3	16 0447	6.9	1 0539	6.3	16 0009	0.9	1 0558	6.4	16 0045	1.0	1 0105	0.6	16 0134	0.9
1115	1.4	1112	0.8	1154	1.3	0613	6.7	1212	1.2	0647	6.6	0705	7.0	0734	6.7
SU 1717	6.3	M 1713	7.0	W 1756	6.5	TH 1231	1.0	F 1816	6.7	SA 1301	1.0	M 1320	0.6	TU 1346	1.0
2333	1.4	2334	0.7	●		1835	6.9	●		1905	6.9	1923	7.3	1949	6.9
2 0534	6.4	17 0537	7.0	2 0016	1.3	17 0057	0.9	2 0038	1.1	17 0125	0.9	2 0147	0.5	17 0204	1.0
1149	1.2	1200	0.6	0616	6.4	0700	6.7	0639	6.6	0725	6.6	0747	7.1	0803	6.6
M 1750	6.5	TU 1801	7.1	TH 1231	1.2	F 1316	1.0	SA 1254	1.0	SU 1339	1.0	TU 1402	0.5	W 1415	1.2
		○		1832	6.6	1920	6.9	1857	6.8	1943	6.9	2005	7.4	2020	6.7
3 0007	1.2	18 0023	0.6	3 0054	1.2	18 0141	0.9	3 0120	0.9	18 0202	1.0	3 0228	0.5	18 0233	1.2
0607	6.5	0625	7.1	0654	6.5	0743	6.6	0721	6.7	0801	6.6	0829	7.1	0832	6.4

Mark-up the graph

2 0016 1.3
0616 6.4
TH 1231 1.2
1832 6.6

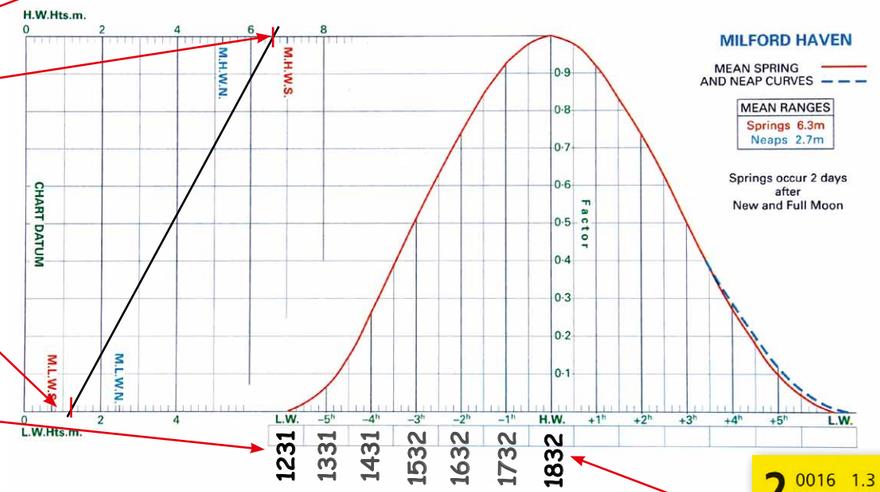
Mark up the Height of High Water

2 0016 1.3
0616 6.4
TH 1231 1.2
1832 6.6

Mark up the Height of Low Water

2 0016 1.3
0616 6.4
TH 1231 1.2
1832 6.6

Write in the time of Low Water



2 0016 1.3
0616 6.4
TH 1231 1.2
1832 6.6

Write in the time of High Water

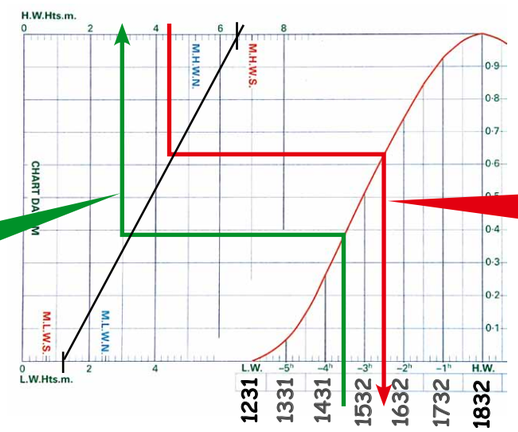
After marking up the heights of High and Low Water, join the marks together with a diagonal line. Then, after writing in the times of High and Low Water, fill in the hourly time-boxes between them – working from either end towards the middle so that any 'overlap' is shown at (the often less critical) mid-tide stage.

Note: When using the graph to establish heights/times (as shown below) use the nearest Spring (—) or Neap (– – – –) Curve. Here at Milford Haven there is mostly no difference.

How to use the graph

What is the predicted height of tide above Chart Datum in the Milford Haven area at 1500?

Enter the time scale at 1500. Go up to the tidal curve, then across to the diagonal line, before continuing up to the height scale. This shows 3 metres.



At what time will there be a height of 4.5 metres above Chart Datum in the Milford Haven area?

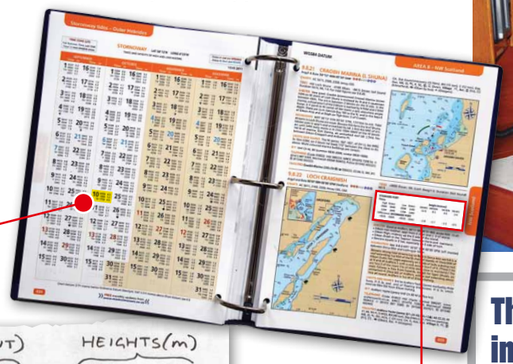
Enter the top height scale at 4.5 metres. Go down to the diagonal line, then across to the tidal curve, before continuing down to the time scale. This shows 1600hrs.

Secondary port interpolation

Providing tide tables and graphs for every harbour would take up too much space in the almanac. To overcome this, only the 'differences' to the LW and HW times and heights at the more widely spaced standard ports are given. Interpolation is then required to obtain heights and times at the many secondary ports in between.

1 Standard port heights and times

First, extract and write down the designated standard port times and heights. Because interpolating and applying the differences can be confusing, a neat and logical layout – as suggested below – is essential.



10 0257 2·7
0833 9·7
M 1514 2·9
2047 9·3

	TIMES (UT) HW	TIMES (UT) LW	HEIGHTS (m) HW	HEIGHTS (m) LW
STANDARD PT	0833	1514	9·7	2·9
DIFFERENCES				
SECONDARY PT				

2 Secondary port differences

The differences are annotated in the almanac in the standard format (right). For example, the HW time differences shown here tells us that when HW at the standard port occurs at either midnight (0000) or midday (1200), HW at the secondary port would be 35 minutes earlier – but when it occurs at 0600 or 1800 it would only be 5 minutes earlier. If HW at the standard port occurs somewhere in between these times (here it's 0833), we've got to interpolate to find the difference. The same concept applies to the LW time difference – and the HW and LW height differences.

STANDARD PORT

Times High Water	Times Low Water	Height (metres) MHWS	MHWN	MLWN	MLWS
0000 0600	0500 1100	11·0	8·1	4·0	1·4
1200 1800	1700 2300				
Differences SECONDARY PORT					
–0035 –0005	–0020 –0042	–2·8	–1·7	–1·3	–0·5

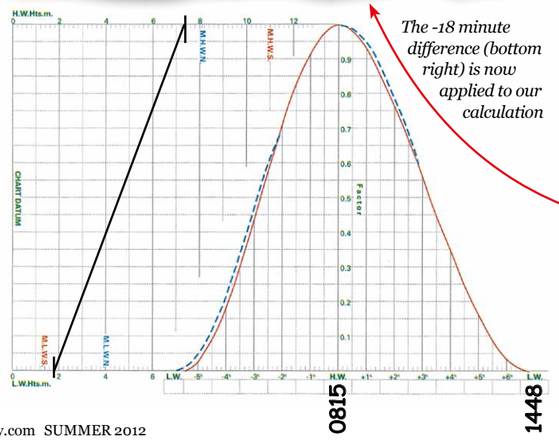
Interpolation step-by-step

3 Apply to standard port curve

Note: Time differences apply to UT times at the standard port. If you're working in BST, wait until AFTER the calculations (right) have been completed before adding the one-hour correction

	TIMES (UT) HW	TIMES (UT) LW	HEIGHTS (m) HW	HEIGHTS (m) LW
STANDARD PT	0833	1514	9·7	2·9
DIFFERENCES	–18	–26	–2·3	–1·0
SECONDARY PT	0815	1448	7·4	1·9

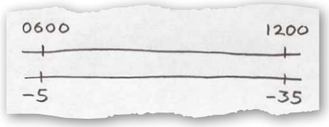
The -18 minute difference (bottom right) is now applied to our calculation



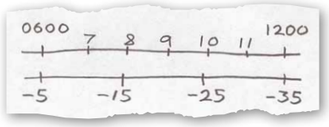
RIGHT: With the secondary port's differences established and applied to the straightforward calculation, the results are then applied to the graph of its designated standard port (right), which is marked up and used in exactly the same way as shown on the previous page

The simple way to interpolate differences

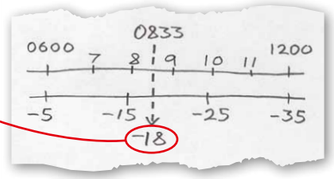
If your mental arithmetic's not that hot, it's best to do any workings on a separate bit of paper. There's usually no need to get over-complicated with a calculator or graph paper. For most purposes we can use two parallel lines – drawn freehand and divided into hours/minutes by eyeball. In this example we want to find the time difference to apply to the day's HW time of 0833.



Draw two parallel lines and mark off, at either end of the top line, the Standard Port's HW times (0600 and 1200) that straddle 0833hrs. On the bottom line, directly below the HW times, mark off the time differences (–05 and –35 mins)



Divide the top line into a six-hour time scale and the bottom line into any convenient scale of minutes (here it's at 10 minute intervals)



To find the difference to apply to the Standard Port's HW time of 0833, simply run a pencil between the two lines. Here, HW at the Secondary Port occurs 18 minutes earlier

PHOTOS: GRAHAM SNOOK

HALF TIDE

It's important to have faith in our calculations when drying out, particularly in the Channel Islands where the tide can rise or fall 2m or more in an hour

'The more faith we have in our calculations, the more interesting places we'll be able to visit'

LOW WATER

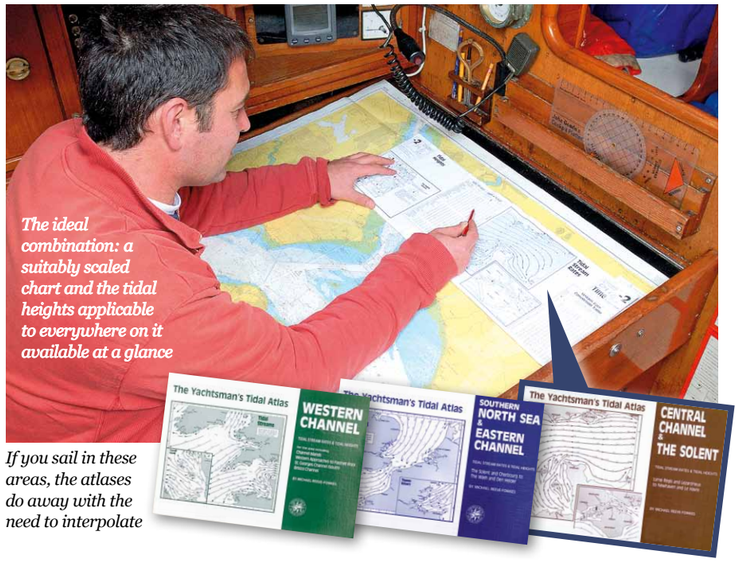
With confidence, we can enjoy more challenging places where others fear to tread. Here, an adventurous spirit and a boat with a lifting keel help!

Tidal heights at a glance

For accuracy and ease of use, my favourite source of tidal height (and stream) data over the past three decades has been the *Yachtsman's Tidal Atlases*, published by Adlard Coles. Based on the time and height of HW Cherbourg (which is all we need from the almanac), they are annotated the same way as any other tidal atlas – by marking up the pages six hours before and after High Water. Thereafter, we can extract 'instant' tidal heights at every Standard and Secondary Port we're likely to visit, for each hour of the 12-hour tidal cycle, without any interpolation.

The atlases are based on the times and heights of High Water Cherbourg because of its central reference position, suitably high tidal range and symmetrical curve. It is also relatively free from the fluctuations in mean sea level that can be prevalent at other more familiar Standard Ports. Conveniently, in summer months the times given in the almanac equate to British Summer Time.

Regrettably, the area of coverage is limited to what's shown on the covers of the three atlases illustrated here, plus one that's solely dedicated to the Channel Islands and another that combines them all.



The ideal combination: a suitably scaled chart and the tidal heights applicable to everywhere on it available at a glance

If you sail in these areas, the atlases do away with the need to interpolate

Example: Find the height of tide at all ports, on 16 September

1 Get the time and height of HW Cherbourg on 16 September (here from Reeds Almanac).

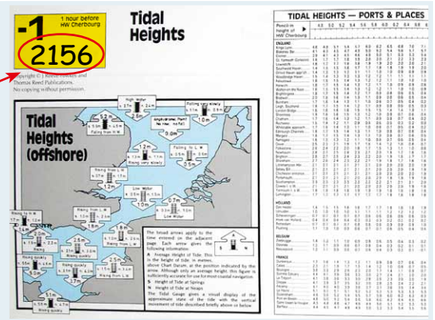
TIME ZONE -0100
Subtract 1 hour for UT
For French Summer Time add ONE hour in non-shaded areas

CHERBOURG — TIMES AND HEIGHTS OF

SEPTEMBER Time	m	Time	m	OCTOBER Time	m	Time	m
1 0520	0.6	16 0513	1.5	1 0538	1.0	16 0512	1.8
1058	6.6	1041	6.0	1113	6.5	1038	5.9
TH 1737	0.8	F 1727	1.6	SA 1758	1.1	SU 1730	1.8
2314	6.7	2256	5.9	2335	6.3	2300	5.7

2 Fill in the atlas's time boxes on each page for the six hours before and six times after Cherbourg's HW time of 2256.

Here, on the HW-1 page, we subtract one hour and write 2156; on the HW+1 page we add an hour, and so on.



3 Mark up the TIDAL HEIGHTS – PORTS & PLACES scale by pencilling-in (the same on every page) the HW height of 5.9 metres.

TIME ZONE -0100
Subtract 1 hour for UT
For French Summer Time add ONE hour in non-shaded areas

CHERBOURG — TIMES AND HEIGHTS OF

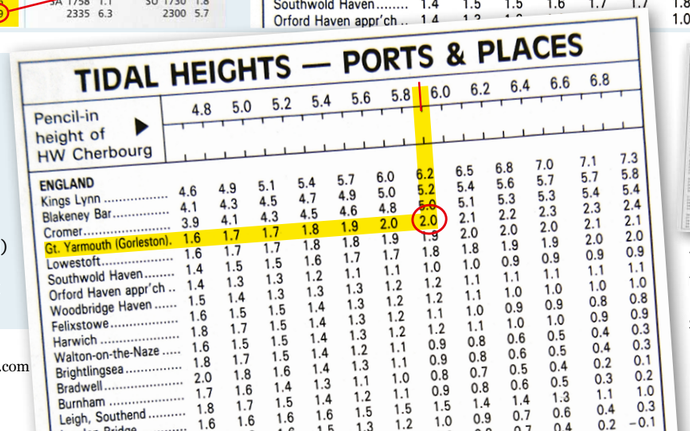
SEPTEMBER Time	m	Time	m	OCTOBER Time	m	Time	m
1 0520	0.6	16 0513	1.5	1 0538	1.0	16 0512	1.8
1058	6.6	1041	6.0	1113	6.5	1038	5.9
TH 1737	0.8	F 1727	1.6	SA 1758	1.1	SU 1730	1.8
2314	6.7	2256	5.9	2335	6.3	2300	5.7

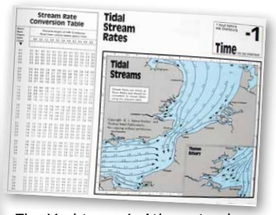
TIDAL HEIGHTS — PORTS & PLACES

Pencil-in height of HW Cherbourg ▶	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2	6.4	6.6	6.8
ENGLAND											
Kings Lynn	4.6	4.9	5.1	5.4	5.7	6.0	6.2	6.5	6.8	7.0	7.1	7.3
Blakeney Bar	4.1	4.3	4.5	4.7	4.9	5.0	5.2	5.4	5.6	5.7	5.7	5.8
Cromer	3.9	4.1	4.3	4.5	4.6	4.8	5.0	5.1	5.3	5.3	5.4	5.4
Gt. Yarmouth (Gorleston)	1.6	1.7	1.7	1.8	1.9	2.0	2.0	2.1	2.2	2.3	2.3	2.4
Lowestoft	1.6	1.7	1.7	1.8	1.8	1.9	1.9	2.0	2.0	2.0	2.1	2.1
Southwold Haven	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.8	1.9	1.9	2.0	2.0
Orford Haven appr'ch	1.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.0	1.0	0.9	0.9	0.9	0.9

RESULT

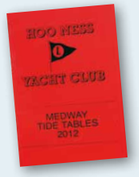
We can now instantly extract tidal height predictions at all of the places we're ever likely to need. Here, at 2156 (one hour before HW Cherbourg) we have 2.0 metres above Chart Datum at Great Yarmouth.





The *Yachtsman's Atlas* not only tells you the height of tide at any port, it also gives relevant tidal stream rates on the facing page

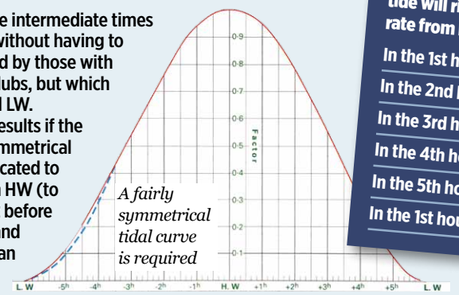
The classic rule of twelfths



Hoo Ness YC tables give HW and LW times and heights for Chatham

The Rule of Twelfths can be used to calculate intermediate times and heights between High and Low Water without having to refer to tidal curves or graphs. It's often used by those with pocket-sized tables issued by many yacht clubs, but which only give times and heights of local HW and LW.

While the 'rule' can produce acceptable results if the area to which it applies has a reasonably symmetrical six-hour rise and fall of tide, it can be complicated to use in practise. Taking the height of LW from HW (to get the range), then dividing the result by 12 before adding up the required number of twelfths and applying them to either LW or HW heights can call for quite a bit of mental arithmetic.



A fairly symmetrical tidal curve is required

THE RULE OF TWELFTHS

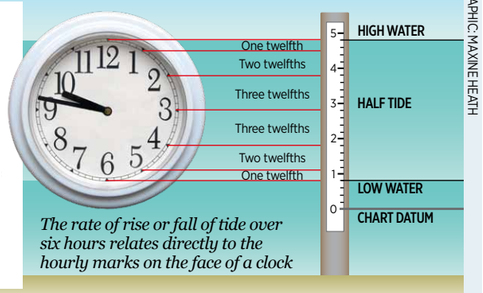
During a six-hour period the tide will rise/fall at the following rate from Low/High Water:

In the 1st hour	1/12 of its range
In the 2nd hour	2/12 of its range
In the 3rd hour	3/12 of its range
In the 4th hour	3/12 of its range
In the 5th hour	2/12 of its range
In the 1st hour	1/12 of its range

Easier to clock the Rule of Twelfths

Fortunately, we can eliminate most of the above number crunching by comparing the Rule of Twelfths to the face of a clock. By extending imaginary horizontal lines from its hour-marks to an adjacent tide gauge, the gradually accelerating and decelerating rise or fall of tide over six hours will automatically be divided in accordance with the 'rule'.

Putting this concept into practice is easy. We only need to divide the range by two, and the result by two again, to mark up the gauge – and substitute the 12 and 6 o'clock points on the clock with the times of HW and LW. Copying the illustration below (in ink) will provide a handy tidal clock that can be quickly pencilled-in whenever it's needed.



The rate of rise or fall of tide over six hours relates directly to the hourly marks on the face of a clock

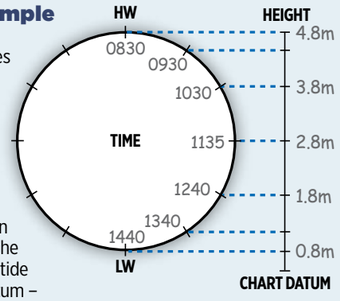
GRAPHIC: MAXINE HEATH

Construct our own simple tidal height clock

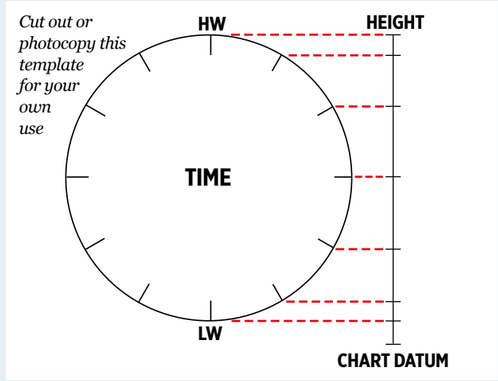
In this example (right), the times of HW (0830) and LW (1440) are pencilled-in on the clock face – and the heights of HW (4.8m) and LW (0.8m) on the tide gauge.

The tide gauge is marked up by halving the 4.0m range (2.0m) and then halving it again (1.0m). By adding the 2.0m to the LW height of 0.8m gives a half-tide height of 2.8m above Chart Datum – with 1.0m divisions between half tide and HW or LW.

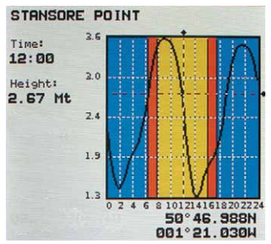
Because there's rarely exactly six hours' rise or fall, when marking up the intermediate hours on the clock it's prudent to show any time 'overlap' at (the often less critical) mid-tide stage.



Cut out or photocopy this template for your own use



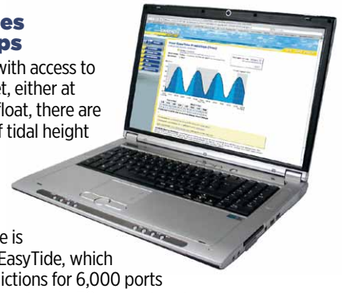
Chartplotters and websites



Electronic chart predictions

These days, most electronic chartplotters use software that can instantly display the predicted height of tide above Chart Datum. Here, in Southampton Water using a C-Map MAX chart, the nearest tide icon (off Stansore Point) is clicked to bring up a display showing a rolling, tabulated 24-hour tidal curve and the current height of 2.67m at 1200hrs.

Websites and apps



For those with access to the Internet, either at home or afloat, there are a variety of tidal height apps and programs for PCs available. Shown here is Admiralty EasyTide, which offers predictions for 6,000 ports worldwide and up to 50 years ahead.

Thanks to

- **Southern Sailing School, Southampton**
  Tel: 01489 575511
  Website: www.southern.co.uk