UNDERWATER NAVIGATION

1. Introduction to Underwater Navigation

Underwater navigation is about getting to where you want to go and knowing how to get back should you need to.

In perfect conditions, that's a simple matter of watching where you're going and retracing your course, which often means keeping a look-out behind you as you progress, to see the view from the other direction.

The art of not getting lost underwater, which in normal British conditions is always a miracle, is formally taught during the BSAC Ocean Diver & Sport Diver courses. It is the subject of two Open Water dives, but after that, you're on your own!

Successful underwater navigation uses two techniques

Pilotage
The Compass

For any dive, a compass is a simple, yet invaluable, tool and, during this course you will hopefully use your compass to find your way from one point to another, to navigate multi-leg routes of dive sites, and to find your way to your exit point at the end of a dive without surfacing first. You'll also practise pilotage, the art of finding your way using only underwater features and, finally, combine both pilotage and compass use.

2. Pilotage

Basic pilotage is making use of distinct, usually natural, underwater features to navigate by. These can be reefs, gullies, distinctive boulders, sand ripples, and also man-made objects such as wreckage and lobster pots.

Reefs and gullies make for easy out and back dive navigation, distinctive boulders and man-made objects make useful way-points, especially if they are used in conjunction with a compass course. Sand ripples may indicate the direction of the beach (i.e. they usually run parallel to the shore), although in certain locations this may not be true.

Be sure to note distinctive features on your outward leg so that they can be 'ticked-off' on the return leg. Pilotage can also be used to define the boundaries of a dive i.e. a small wall, distinctive large rock or drop-off – make sure that these are distinctive enough so as not to be missed on the outward leg! Make sure in the dive plan that you both clearly know what pilotage features are being used!

Diving in Britain, it can be difficult to use the sun as a point of reference, and even if you are lucky, it is still difficult to use unless you are diving early in the morning or late afternoon. Refraction through the surface can make it seem always to be directly overhead when it is not.

Currents can change direction during the period of the dive with the ebb and flow of the tide, so should be used with caution. The underwater topography can also influence the direction and strength of the current, and this may give an indication of your whereabouts underwater.

If the terrain is less dramatic, you might need to note the depth. This usually increases the further from shore you are, although not always. In this way, your computer or depth-gauge becomes a navigation instrument by indicating your exact position in the water column. Noting depth changes is particularly useful when other reference methods are not available. Similarly the observation of bubbles - which, scientists have found, usually go up - can come in useful.

3. The Compass

Basically, a compass is a magnet suspended so it can rotate freely and point toward the earth's magnetic North Pole. All dive compasses are filled with fluid and have a floating card with an arrow on it that points north. The fluid serves three purposes: it allows a reading to be obtained even if the compass isn't perfectly level; dampens the movement of the needle or floating card so it doesn't swing wildly; and allows the compass to withstand the pressure of water at depth.

There are two types of compass: direct and indirect. On a direct reading compass the degrees are marked on a rotating bezel; on an indirect reading compass they are not. Many dive compasses are both: degrees are marked on the rotating bezel as well as on the compass card. All compasses, whatever the type, will have degrees from 0 to 360 marked on them, usually in 30 degree increments. Some dive compasses also have the cardinal points – North, South, East, West - indicated on them. The cardinal points symbols assist when an accurate bearing is not being followed and they are usually easier to interpret (i.e.. head east into the beach).

Some compasses have a sighting window to enable you to read the degrees marked on the compass card (N.B. For 'sighting' compasses, the degrees marked on the compass card are usually 'reversed' so that the correct bearing is read when the sighting window is used). If used, the sighting window will give a more accurate bearing.

Compasses come in several different styles; the most common one is built into the gauge console. Others attach to the high-pressure hose above the console and a third type is worn on your wrist. The components are always the same.

An Indirect Compass

A Direct Compass

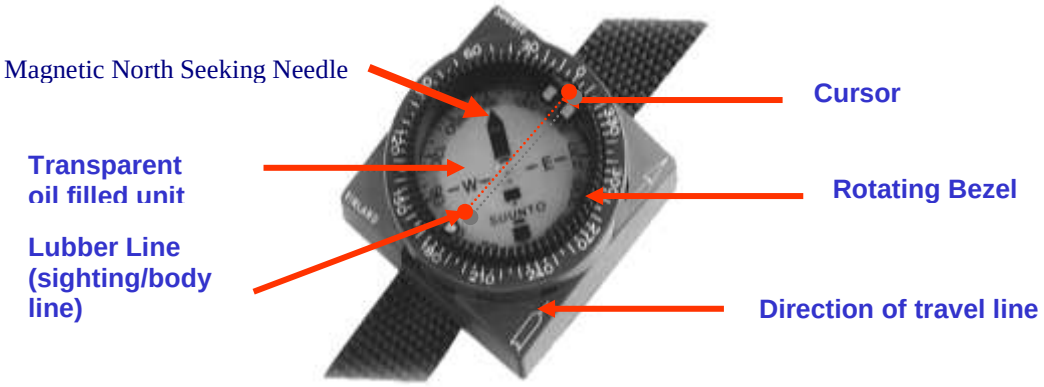
4. Anatomy of a Compass

The card: This round piece of magnetic material floats inside the body of the compass and always points north. Look for a simple, uncluttered display with the cardinal points and degree numbers marked between those points. . If you rotate your compass, the card will always point to the north.

The lubber line: All dive compasses have a lubber line. This is usually an etched line that runs straight down the face of the compass. It forms a sight to help you point and aim the compass and indicates your direction of travel. In some wrist-mounted compasses, the lubber line will be indicated on the square compass casing.

The bezel: Dependant on compass type, the bezel may have degree calibration marks reading from zero to 359 degrees. The bezel will also have one or two reference marks, also known as cursor points. The primary reference marks are normally used to 'frame' the north-pointing arrow on the card. A secondary, reciprocal, reference mark may also be present, which will assist in making a reciprocal course during a dive.

Sighting window: A sighting window allows you to sight the compass between your eye and your destination and lets you read a very accurate bearing, from the compass card.



4. Where to Mount the Compass

When using a compass, it is vitally important that it is held perpendicular to the divers body. It's common to see a compass incorporated into the instrument console. It's convenient, but the fairly short high-pressure hose can make it awkward to hold the console so that the compass is level, easy to see and perpendicular to the divers body.

Mounting the compass on your wrist or on a retractor clipped to your BC makes it easier to manipulate. Even better is to mount it in the corner of a small slate. The edge of the slate works as an extension of the lubber line, making it easier to point the compass accurately. The surface of the slate is also a reference plane, making it easier to hold the compass level. The slate itself is useful for noting courses. And if you're making a sketch of the dive site, you can align north on the sketch to north on the compass. Now your sketch aligns with reality: What's to your left on the slate will be to your left as you swim.

5. How to use the Compass

Dive compasses are easy to use. Three things are super important in underwater navigation:

a. You must remember to take a reading at the beginning of the dive,

b Keep the compass level to avoid jamming of the compass card, and

c. To align your entire body with the lubber line The lubber line is positioned perpendicular to you shoulders and pointed straight ahead in the direction you want to go. For wrist worn compasses this is accomplished by placing the hand of the arm on which you are wearing the compass on the elbow of the other arm, which is held straight in front of you. Then line up your head, torso and feet with the lubber line. It may be easier to remove a wrist-mounted compass and hold it in both hands instead. If the compass is in a console, hold it in front of you and line your body up with the lubber line as with the wrist-mounted compass.

Hold the compass at slightly below eye level so you are sighting over it instead of down on it.

6. Bearings

All compass navigation is based on the card's magnetic attraction to north. Though the compass card appears to move as you change course, in reality, the diver is only moving the body of the compass around the free-floating card. It's this consistent alignment to north that makes the compass a useful tool for determining and monitoring a path of travel.

To navigate you must establish a course. Here is how it's done:

1. You normally establish your course from the shore or boat just before entering the water. Point the lubber line in the direction you want to travel.

2. Rotate the bezel until the primary cursor points 'frame' the north arrow.

3. Note your planned course in degrees. Most compasses have numbers marked every 30 degrees; for instance, 30, 60, 90, 120, etc. But note that many compasses substitute E for 90, S for 180, W for 270 and N for 0/360. This 0/360 mark is usually also marked by an arrow or the company's logo. Let's say your course is 40 degrees.

4. To maintain course under water, just swim forward, keeping the north arrow between the primary cursor points.

5. If you stray off course, you'll see the arrow move to one side or the other of the cursor points.

6. To get back on course, swim to the left or right, depending on which way you strayed, until the north arrow is again between your cursor points. As long as the north mark remains between the cursor points, you're on course.

7. Compass Deviation

Your compass works by pointing its needle either towards the planet's magnetic north, or towards the nearest mass of ferrous metal (metals that contain Iron), or else it combines the two effects.

Dive compasses won't be affected by most dive gear because it contains little iron (since iron rusts) and because of the amount of water between the compass and the gear. You can find out what objects affect your compass by holding each object nearby to see if there is a reaction. If there is, just make sure the object is not close to the compass when you are taking a reading.

Keeping your compass away from your tank is one thing. When diving on a steel wreck, you will have to either use pilotage or use a distance line to find your way.

8. Reciprocals

If you are swimming a straight (ish!) outward course, to return to your starting point simply reverse your course. To do this either:

a. Slowly rotate your body until the north arrow is in line with the secondary (reciprocal) cursor points, OR

b. To find your return course, either add or subtract 180 (If the original bearing is less than 180, add 180. If the original bearing is greater than 180, subtract 180). . Carefully reset the bezel to the new course and slowly rotate your body until the north arrow is ‘framed’ between the primary cursor points again..

Swim forward, keeping the north arrow lined up with either the primary or reciprocal cursor points (dependant on the method used to reverse the course). You should eventually end up back where you started.

9. Simple geometric patterns

For simple geometric patterns, a square or a triangle for instance, at each turn-point of the pattern you will have to either add (for right turns) or subtract (for left turns) the angle of turn (in degrees) from your current bearing.

To make a 90° right turn, add 90° to your present course. Subtract 90° for a left turn. Assuming that the original bearing is 40°, a 90° right turn will give a bearing of 130°. A 90° left turn will give a bearing of 40° - 90° + 360° = 310

Check your addition and subtraction – it may be easier to write it on a slate. Rounding off to the nearest 10 degrees will simplify addition and subtraction. Over the short distances typical in recreational diving, an error of five degrees or so won't matter.

To swim a simple equilateral triangle, the calculation required at each turn will be to add or subtract 120° to the current bearing.

For any simple geometric pattern, accurate control of the distance swam is vital if you are to successfully return to the start point.

10. Distance & Timing

Finally, a word to the wise: A compass cannot pinpoint the exact location of an object, just its direction from a given point. Although it will get you back to a beach easily, you might swim right under and beyond your boat before you realise it. There are several methods to estimating distance and timing a 'leg'.

Distance can be estimated if you know one of two methods:

a. How long does it take to swim a set distance (i.e. 50 metres)
b. How many fin strokes it takes to swim a set distance (i.e. 50 metres)

Once one or both of the above methods are known, it is relatively simple to estimate distance travelled underwater. However, a note of caution, the distance covered within a set time or number of fin strokes will vary dependant on kit configuration, current, diver fatigue etc.

It is also useful for the buddy to control the timing or fin stroke count as the leader will be concentrating on the compass navigation. For the leader to do both may lead to over-tasking and ultimately getting lost!

One final method of distance estimating is air consumption. This method is however fairly inaccurate unless used as a general indication – i.e. in a normal diving situation, one-third of the divers air will be used for the initial descent and swim to the turn-round point. Another one-third of the divers air will be used to return to the ascent point. Again, distance covered using this method will vary greatly with kit configuration, depth etc., so care is needed if the diver is attempting to use this method for anything more than a rough guide.

11. Compass & Pilotage combined

Feature-hopping

If you spend your dive slavishly studying the compass, you will see precious little else. Take a sighting in the direction you wish to travel and take note of any distinctive features which lie en-route. The closer the features are to the limit of visibility, the more you will enjoy your dive. The distinctive features may be a rock, coral head, man-made object (Lobster Pot etc.), but once chosen you can enjoy your dive, heading in the general direction of the feature. Once at the feature, repeat the process.

Aiming Off

Aiming off is another method of pin-pointing a dive objective (wreck, cavern, boat mooring etc.). This method relies on using a distinctive, and preferably large, 'collecting' feature. The collecting feature, be it a wall, drop-off, distinctive area of sand/vegetation, gully, pipeline, cable etc., will be situated in a known direction from the actual diving objective. The diver will take a general bearing to the 'collecting' feature and once there will know which direction to navigate to get to the objective. The diver may have an accurate bearing to follow from the collecting feature to the objective, or it will more likely be that he follows the wall/gully/drop-off in a pre-determined direction to find the objective.

12. Advanced Compass work

Crossing a current:

There are two methods to navigate across a current.

1. Angled finning

With this method, you take and set a bearing as normal. Once underwater you retain the set bearing and swim towards it, angling your finning to counteract the current. This will only work for a slight current (< 1 knot). Providing the visibility is reasonable, you can use feature-hopping to assist your crossing.

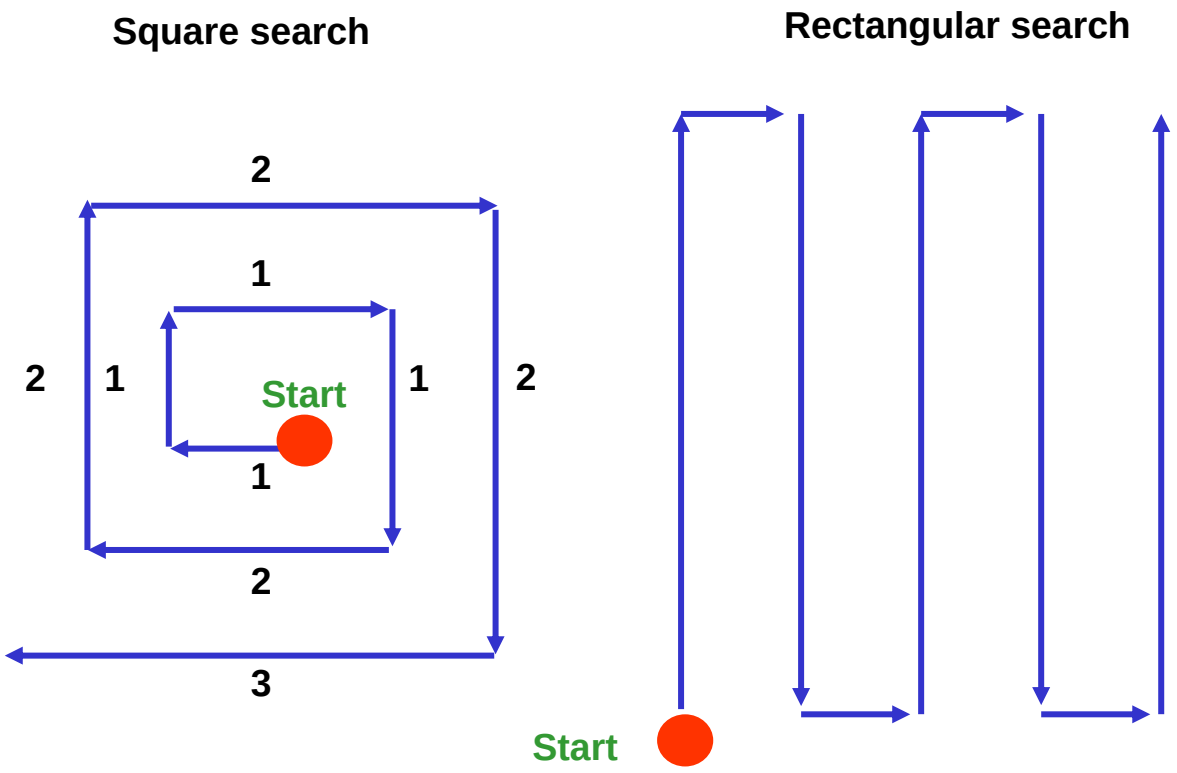
2. Aiming-Off

You know you need to aim up current in order to compensate for the flow and arrive at your target. But how much up current? As a rule of thumb, aim 20° up current for every ½ mph of current.

Here's why: the best speed most divers can maintain over a distance--not a sprint but faster than cruising--is about 1½ mph. If you swim at 1½ mph at a right angle to a current of one-half mph, it will sweep you off course by about 20 degrees. Obviously, if the current is more than one knot you'd better think carefully before you try it. If the current is not at right angles to your course, or you are prepared to swim harder, you will have to adjust the figure, but if you can aim-off to a positive collecting feature, then the navigation should be successful.

Search Patterns:

Once you have mastered controlling your distance and navigating a simple square or rectangle, these techniques can be used to swim a search-pattern. Two patterns lend themselves to compass work – a square search pattern and a rectangular search pattern. Both require practise, but are very effective search patterns using minimal equipment and manpower.



13. Night Navigation

KISS – Keep It Simple, Stupid! Do not make navigation during night dives complex. A simple reciprocal, out & back swim should be the most complicated navigation that you attempt. Simple Pilotage along a reef wall, for example, is also a useful option. The exit point should be clearly marked with a light – glow stick, strobe, car headlights etc.

14. Temporarily Misplaced

Also known as being lost. Some divers try to attach some stigma to this occurrence, however it will happen to all divers at some point in their diving career, no matter how good you are! If you should find yourself lost – STOP, THINK, ACT!

- Attempt to work out how far you are off course
- Try to remember a distinctive feature that you have passed, where you know that you were on the right course - can you return to this feature, re-establish your position and continue the dive.
- Are there any hazards which may endanger you and your buddy if you continue on your dive. If there is, do you have a 'bail-out' bearing away from this hazard and returning towards your pre-determined exit point.
- If you are unable to re-establish your position, or change the dive plan safely, then abort the dive, but only do this when it is safe to do so.
- Do not surface in busy shipping channels – try to swim to one side before ascending using a Delayed SMB.
- Always dive with some method of attracting surface attention if you are going to surface along way from the boat/exit point.

15. Summary

A compass is a cheap, but surprisingly reliable item. Make sure you know how to use one, by referring to your training manual and practising. Learn to trust it and KISS – Keep It Simple Stupid!

Dry Practicals

1. Setting a Bearing
2. Pacing & Timing
3. Out & Back (Reciprocals)
4. Simple geometric patterns

Surface Practicals

1. Setting a Bearing
2. Pacing & Timing
3. Out & Back (Reciprocals)
4. Simple geometric patterns

Underwater Practicals

1. Setting a Bearing
2. Pacing & Timing
3. Out & Back (Reciprocals)
4. Simple geometric patterns
5. Pilotage
6. Pilotage & Compass work