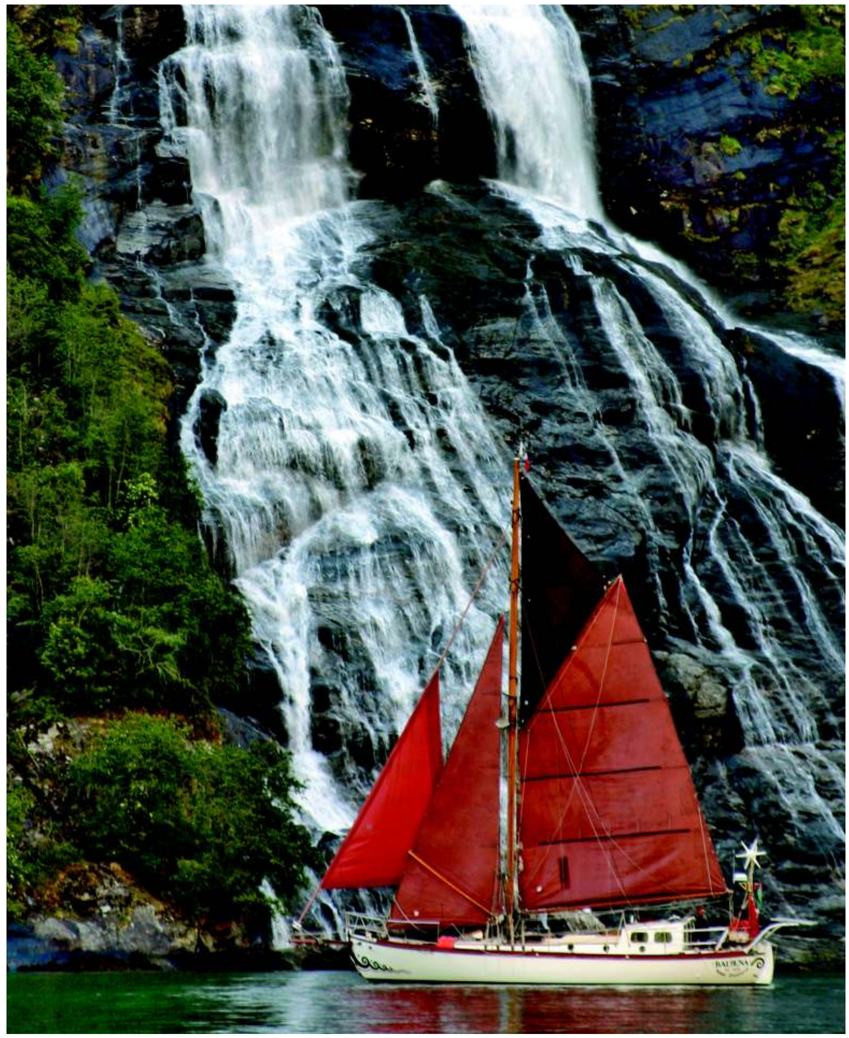
Bluewater Gear

An echo from the future

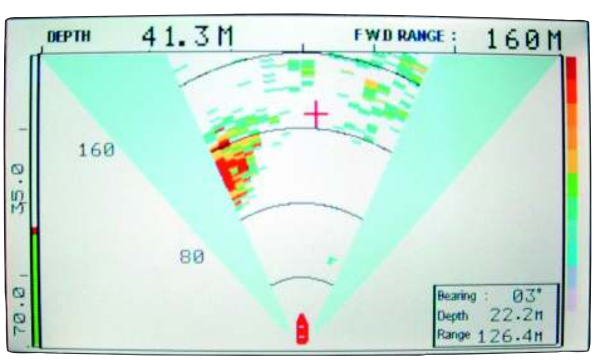
Balæna's experience: Choosing, fitting and using forward-scanning sonar

Story and photos by Andy O'Grady



Right, O'Grady's 42-foot wooden cutter Balaena *near a waterfall in Greenland. Below, the sonar unit added by O'Grady provides depth data ahead.*

Aboard our 42-foot gaff-rigged cutter *Balæna*, we particularly enjoy voyaging to less visited places, such as the fjords of Greenland or Patagonia. Poorer countries and more remote areas of developed lands often lack charts with the detail and accuracy that we expect when sailing in the U.S. or Europe. Sailing in those waters carries a risk of collision with uncharted dangers. In addition, choosing a secure anchoring place often involves a preliminary survey to ensure that we won't be bumping into a rock if the tide goes out or the boat swings with a change of wind. Even quite detailed charts can miss out on features required for this task, and who's to say that someone has not decided to scuttle an old barge in the place that we chose? Such surveys have often resulted in a bump to our keel, and over the years we have talked about how fine it would be to have the ability to look forward and see what lay ahead.



Five years back in Patagonia, where many useful anchorages are just white blanks on the chart, we even experimented with a standard fish finder mounted in the bow and looking forward at an angle of about 20°. This did give us some forewarning of underwater obstructions but the display was so difficult to interpret that we abandoned the idea. Since then we have been watching the development of forward-scanning sonar and wondering when we would be able to afford one.

Sailing in the muddy waters of the Intracoastal Waterway we often touched bottom where markers were far apart and the dredged channel narrow. We wished for a forward scanner that gave a horizontal picture and allowed us to see where the channel was. Uncharted dangers were not a problem on the North American East Coast until we reached the north of Labrador and once again had to use charts that had large blank spaces marked "many uncharted dangers are believed to exist in these waters." One time pack-ice blocked the only route where, in 1927, Dr. Wilfred Grenfell's survey ship had made one line of soundings. *Balæna* was forced to sail for hours over the blank part of the chart in almost total ignorance of what lay under the waters ahead. How we wished for a forward-scanning sonar that would show a rock rising precipitously up from the seabed.

In Greenland we saw ice every day, huge icebergs or broken pack-ice but occasionally, in what appeared to be clear water, we would suddenly see a small (remember you only see one-tenth of a piece of ice; the rest is below the surface) growler right ahead. Mostly we avoided them but we still had half a dozen hard knocks on the hull during our three months in those waters. How nice it would be to have a sonar scanning ahead just below the surface to warn us of lurking dangers.

We could never decide whether it would be better to have a horizontal or vertical scan. The first such device we ever saw was an EchoPilot unit aboard a yacht in harbor. The display clearly showed the harbor wall lying some distance ahead. We were impressed.

Finally this year it looked as though we could afford a unit and we started to assess the options. We found two instruments suitable for a yacht using solid-state electronic transducers as opposed to those that can be mechanically steered.

• The most economical was the EchoPilot that we had already seen and liked. This had a clear display and simple controls, but range and depth were very limited — not so important in an anchorage but important if trying to spot hidden rocks or ice ahead when steaming. There was no horizontal scan option. The transducer is plastic and requires a 1 3/4-inch hole to be cut in the boat, no small issue for a skipper who refuses to have more than one underwater seacock on the whole boat.

• Interphase has a reputation for quality and service. The company's word of mouth on the voyagers' grapevine — probably one of the most reliable sources — was very high, and it had started to sell units that combined both functions in one set. The transducer was very large but was mostly bronze and only required a 1-inch hole in the hull, something that I found much easier to live with. Plus, Interphase offered factory reconditioned units at a substantial discount, which made the price just attainable. I was also greatly impressed by the immediate, detailed and helpful replies Interphase gave to my e-mail inquires. We decided to take the leap and buy an Interphase Color Twinscope.

Installation issues

A normal sonar or fish finder can be mounted almost anywhere, though it is best to stay away from turbulent areas, such as around the bow. Conventional voyaging boats mainly have wineglass-shaped hulls so they will require fairing blocks to give a level surface. Transducers with a shaft length of four to five inches will be suitable for fiberglass or wooden hulls. (A modern fiberglass boat with an almost flat bottom requires much less length.) Most people mount the transducer just below the turn of the bilge to one side of the keel, and this will be fine for downward-looking units. But if the sonar is also going to scan horizontally the keel will get in the way. Again, modern boats with flat sections can probably mount a transducer just to one side and slightly back from the forward edge of the keel. However, our experience is that around 50 percent of the voyagers that sail to the sort of places where forward-scanning sonar will be most useful have more conventional hull forms. The only option then is to mount in the stem or just to one side. Interphase recommends that, in order to avoid reduced performance due to turbulent water and bubbles

Top, drilling the large counter-hole required for the retaining nut. Second from top, O'Grady chiseling out a recess for the transducer. Third from top, preparing the transducer with non-solvent-based sealant. Above, after fairing the transducer with polystyrene foam and epoxy filler, the unit is painted.

Sonar capabilities

The Interphase sonar unit can be used in a variety of ways. Here is a sampling:

» **Survey of a new anchorage:** Looking for an anchor place in a bay with depths of between 10 to 20 feet we used vertical display at a range of 100 feet. We were able to see where the mud bottom shelved toward the surface up to 100 feet ahead, and at one point we saw a very strong echo from a quay wall at 100 feet when we were in 10 feet. This is fantastically useful for our sort of sailing — the whole bay had only one sounding! Making such surveys we find it better to think in terms of boat lengths or even anchor scope ahead rather than in feet. In this example we were in about 2 1/2 boat lengths, which I think illustrates how slowly you must go in order to have time to react. On another occasion we came into a bay where it suddenly shelved from 15 feet to 2 feet. We spotted the mud bank on the sonar about 1 1/2 boat lengths ahead but were going too fast to react in time.

In practice, because of the limitations mentioned below, we tend to set the range and gain ahead of arrival at the point where we will need to use the instrument, making it necessary to fall back on the old fish finder until we get there.

» **Finding the deepest water in a channel:** The unit does this well. Using the horizontal scan it is fairly simple to see where deeper and shallower water lies, though complicated situations require experience to interpret. In shallow water, the reflections that lie closest will be shallower than those farther away. To determine depth ahead it is necessary to face the area of interest and check with the vertical view. This of course takes time and means that you have to be virtually stationary. In deeper water the horizontal display can be very helpful in checking ahead to see where shallows lie. We often use it when coming up to headlands or seamarks to assess how far an obstruction extends. Following a coastline in the dark, for instance, can be easier using the horizontal view to show exactly were the shallow water is.

» **Forewarning of rocks and reefs ahead:** Both horizontal and vertical scanning can be used for this purpose. We tend to reduce the width of the beam in horizontal so that scanning time is faster. We have picked up dangers more than 1,200 feet ahead (because of the radial shape of the horizontal display, a considerably greater distance is displayed out to the sides). If these lie to one side of the course, no further information is required. But, as (at a range of 1,200 feet) the horizontal display cannot tell you if it is a rock at 100 feet or it has only 2 feet of water over it and is being cut by the beam at 140 feet, a switch to vertical view is needed when the object is right ahead. However, at a suitable range it is also possible to wait and see if the obstruction disappears from the screen as it gets closer, which it will do if it was only just shallow enough to meet the beam at the range when it was first seen. As you get closer the beam will pass over the top of it and it will disappear from the screen. Incidentally, a flat bottom shows up as a radial band ahead of the boat at approximately five times the depth, which stays in the same position on the screen. If the object is moving nearer on the screen then it is getting shallower. On the whole we find that the vertical view is the best to use for spotting dangers ahead.

Unfortunately, we cannot look at the screen all the time, so if there is a mark or headland to alert our attention, this function works well, otherwise we need an alarm, and this function was not so good.

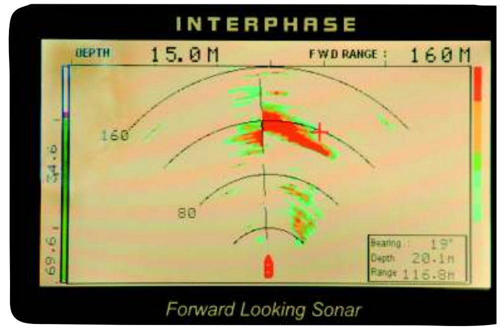
» Forewarning of surface dangers ahead: The unit performs well in this situation. Ships passing ahead at the limit of our range show up as a surface echo, even the wash from a fast-moving power boat can often be seen. If worried about surface obstructions the vertical scan width can be reduced to the minimum so that it is updated faster; this means that only a relatively shallow band ahead is being scanned. We have tested performance in this configuration by deliberately turning toward a rock wall near the limit of range (not hard to do in a Norwegian fjord where water depth can be 1,000 feet at the same distance from a rock face), and it shows up immediately and clearly. A better alarm would also be useful here, however.

Andy O'Grady

dragged under the boat, the mounting should not be closer than one-third of waterline length from the bow. This is just not possible on many voyaging hulls.

Interphase offers a two-transducer option, which would solve most of the above problems, but I was not willing to drill two holes in the hull and have the associated extra drag.

Stems should be pretty heavy, even in fiberglass boats. Ours was 12 inches thick at the point where we decided to mount the transducer. We were able to chisel into the stem to make a recess for the transducer, and this helped reduce the distance somewhat, but it still required more than the 6-inch shaft supplied with the transducer. We had to drill a 1 3/4-inch hole from the inside down to the point where the retaining nut could be fitted. (On a fiberglass boat a fairing piece would be needed inside and out, that thickness would have to be



Two views of a point and jetty. Top, as seen from the deck and, above, the underwater view as seen by the Interphase sonar. The display is in the process of being refreshed (see radial line indicating screen redraw) and the closer red patch on the left indicates shallower water is closer to the boat.

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Geographic range table

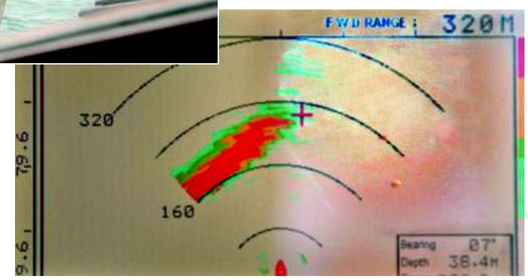
The following table gives the approximate geographic range of visibility for an object that may be seen by an observer at sea level. It also provides the approximate distance to the visible horizon for various heights of eye. To determine the geographic range of an object, you must add the range for the observer's height of eye and the range for the object's height. For instance, if the object seen is 65 feet, and the observer's height of eye is 35 feet above sea level, then the object will be visible at a distance of no more than 16.3 miles:

Height of eye: 35 feet	Range = 6.9 nm
Object height: 65 feet	Range = 9.4 nm
Computed geographic range	=16.3 nm

The standard formula is d = 1.17 x square root of H + 1.17 x square root of h, where d = visible distance, H = height of the object, and h = height of eye of the observer.

HEIGHT		DISTANCE
Feet	Meters	NM
5	1.5	2.6
10	3.0	3.7
15	4.6	4.5
20	6.1	5.2
25	7.6	5.9
30	9.1	6.4
35	10.7	6.9
40	12.2	7.4
45	13.7	7.8
50	15.2	8.3
55	16.8	8.7
60	18.3	9.1
65	19.8	9.4
70	21.3	9.8
75	22.9	10.1
80	24.4	10.5
85	25.9	10.8
90	27.4	11.1
95	29.0	11.4
100	30.5	11.7
110	33.5	12.3
120	36.6	12.8
130	39.6	13.3
140	42.7	13.8
150	45.7	14.3
200	61.0	16.5
250	76.2	18.5
300	91.4	20.3
350	106.7	21.9
400	121.9	23.4
450	137.2	24.8
500	152.4	26.2
550	167.6	27.4
600	182.9	28.7
650	198.1	29.8
700	213.4	31.0
800	243.8	33.1
900	274.3	35.1
1000	304.8	37.0

Source: Defense Mapping Agency, *The American Practical Navigator* (Bowditch); U.S. Coast Guard, *Light List*.



Left, rounding a headland, it appears the boat is well clear. Right, the radar image confirms the visual. Below, yet the sonar image shows the headland extending underwater across the boat's track.

added to the stem thickness and might get very close to 6 inches.)

The transducer was 4 inches wide and 2 1/2 inches high. It was not particularly hydrodynamically shaped and needed quite a bit of fairing to minimize turbulence. We sealed the cut edges of our mounting position with heavy glass cloth and epoxy resin and then used pieces of polystyrene foam coated with epoxy to achieve the fairing. It is recommended that the unit is painted with water-based bottom paint. Solvents are said to damage the construction material. No such paint was available at the yard where we hauled out in Norway. We coated the unit with epoxy resin and then used regular bottom paint over that.

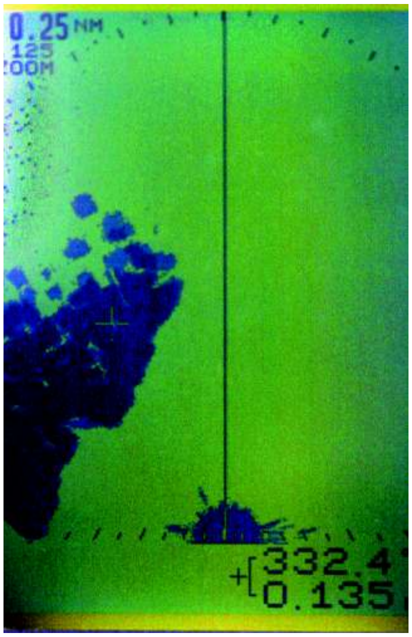
There are two cables to lead through the boat. The cable supplied was 30 feet long and just sufficient to reach our navigation station. Here we mounted the display and found the mounting base to be rather oversized, as we were mounting on a bulkhead, so the base had to be turned back behind the unit, which stuck out considerably farther than our other instruments, such as radar and GPS.

After checking for leaks, it was time to see how the unit would perform. We were near Ålesund on the west coast of Norway, probably ideal conditions to try out the sonar. The underwater geography of the fjords is every bit as dramatic as above water. Rocks can appear near the surface when surrounding water is hundreds of feet deep, but the charts are excellent so there should be no excuse for collisions while learning.

We spent a lot of time learning to use and interpret the display and were far from competent even after a few months of intensive practice. There is no magic signal that says "watch out, rock ahead;" we just had to learn to interpret the display. So we had more near misses in the first few weeks after installation than before. It would have been hard to do this when sailing single-handed. The best way to practice is to find a shallow channel that is navigable but has known dangers, and steam back and forth trying out different display options.

The Interphase Color Twinscope is a fantastic piece of technology that should be welcome on any serious offshore voyaging boat. There are limitations but they are outweighed by the advantages. This is not a simple piece of equipment and requires careful installation and setup, study of the manual and much practice on the water. A good comparison is with radar, which does a similar job and also requires skill and experience to interpret. Radar, however, works in a range of miles, while the Twinscope works in feet!

When reading the display it is important to keep in mind that different



bottom types and the angle at which they lie to the sonar are important factors in interpretation. Soft mud gives a weaker reflection than rock (that is quite convenient as we are much more concerned about rock than mud). An upward sloping bottom ahead returns a strong echo, while a level bottom gives a weaker return and a downward sloping one the weakest or no return. The colors on the display are graduated to indicate strength of return (not necessarily the same as density of the object — a fact that is important to remember) and this makes interpretation very much easier.

Practical limitations

■ Beam angle: The Twinscope's horizontal beam is at about 10° from the water's surface. I suspect that to arrange for a beam with controllable angle would require a large mechanical transducer or a considerable increase in complexity and expense if done electronically. The angle of the beam means that it strikes a level bottom at a distance ahead of approximately five to six times the depth. In effect, this means that the range is limited to five times the depth, whereas in favorable conditions the vertical view may be able to perform better.

Room for improvement?

After some time using the Interphase sonar unit, I've put together some thoughts on possible improvements.

» **Alarm:** The built-in alarm is almost inaudible, especially when the motor is running. In a unit of this quality and expense it surprises me that the customer has to fit an external alarm. This is not only a question of expense, as I imagine the part required would add only cents to the manufacturing cost. The controls for setting the alarm are rather crude and only allow for selection of a certain depth in vertical or forward distance in horizontal view. In practice, if there is nothing in the forward view, the gain will be high and there will be noise and surface clutter that will activate it. The surface clutter (STC) control allows the instrument to ignore returns down to a selected depth, but there is a danger that by setting it too deep, surface objects will be missed. A better system may be to have a box that can be sized and positioned to include a user-determined area for alarm scanning, such as the guard zones found on radars.

» **Changing range:** I found that the constant need to change range and then readjust gain was annoying. It used up much time that should be spent keeping a lookout or even enjoying the scenery. Some areas may not have such dramatic and frequent changes of depth as Norway, and many users prefer to fine tune gain themselves. However, I think that the option to have automatic range control and a gain that reverts to automatic from manual when range changes would make the instrument so much easier to use. There would, of course, still be a need for manual override.

» **Gain control:** Because gain has to be adjusted frequently I would like to see a dedicated full-time gain control. That would reduce the keystrokes and user concentration required. Ideally this would be a "twist" control in the form of a rheostat, but it could also utilize the up/down button on the display, which doesn't have any other unique function.

» **Depth function:** As a stand-alone depth sounder we found that the unit did not match up to our simple fish finder. It is capable of giving very precise depths and a good historical display of the bottom. However, where depth is changing over the course of a trip, range and gain have to be adjusted manually, a function that is automatic on most modern equipment. A depth readout that was displayed regardless of the range setting selected would be useful. I would also appreciate larger figures for the display and maybe better labeling of the vertical scale to allow for easier reading of depth direct from the display. My suggestion is to free up room on the display by removing the color bar when not needed for color tuning and replace it with more scale detail.

» **Selection of units:** The units selected by the user have a dramatic effect on the range of the display, though not of the instrument. At the upper range the maximum is 320 meters (1,050 feet), 1,200 feet and 240 fathoms (1,440 feet). This means that users of fathoms can "see" 390 feet farther ahead than those who choose meters. I can hear many people saying, "We only use feet and fathoms, so what's the fuss?" Remember that this instrument is going to be very useful to those who sail outside U.S. waters, where local charts are going to be in meters. This arbitrary arrangement seems incomprehensible, so why not have the same range, rounded to a convenient figure, in all units?

» **Display ratio:** In shallow water the trace is crammed up against the top of the display and can be difficult to read unless you decrease the range, which may mean missing dangers ahead. This may be important if we are looking for a way over an obstruction into a sheltered pool — not an uncommon thing for us to be doing. I would have liked the option to magnify/zoom the depth scale by *2. So if we used a 100 feet forward range we could have depth range of 25 feet instead of 50 feet.

» **Keel offset:** There is a nice option to adjust the depth display to represent depth below the keel. Unfortunately, if one uses this then the scale that appears on the display will be divided into inconvenient units that make interpolation of depths very awkward.

» **Transducer:** I would have liked a more streamlined transducer and the option to extend the shaft for fitting through the thick stem of a wooden boat.

» **Manual:** The manual is comprehensive and clear, but I would have liked a more detailed appendix on use and interpretation of the display.

Andy O'Grady

Because the obstruction is cut by the beam at a certain depth only, it may be difficult to decide how deep it is.

■ Scanning time: The scanning time limits the speed with which the display is updated; objects can suddenly change position on the screen when the boat is moving or turning. Faster scanning time is presumably not possible because of the relatively slow speed of sound. The scanning speed automatically increases with shorter range.

■ Gain adjustment: Surface clutter and noise are always problems with sonar, with high gain settings and long ranges there is often the appearance of an obstruction just ahead of the boat, and in rough weather it can be difficult to distinguish objects close to the surface. The image can be greatly improved by careful manual adjustment of the gain control.

■ Power consumption: The unit's electrical needs are very reasonable at about 1 amp, but it is about 10 times that of our old depth sounder.

The Interphase Color Twinscope is a true look into the future. I believe that conventional depth sounders will rapidly give way to forward-looking sonar, and this instrument leads the way.

I have been impressed by its performance and abilities, and the criticism I have raised can be seen as mainly a wish list for improvements. Interphase invites user feedback, has been very helpful and speedy in answering my questions, and has promised to look into my suggestions for improvements. It is possible that some of them may be implemented by the time this article is published.

Andy O'Grady grew up in England and Ireland. He sailed to New Zealand in a 26-foot wooden boat built in 1939, where he spent four years building Balæna *while working full time in a medical practice. O'Grady and his partner Ulla Norlander have written on a variety of voyaging topics. They've edited the second edition of the* RCC Pilotage Foundation Guide to Chile *and have co-authored* A Guide to Ocean Passages and Landfalls *with Rod Heikel.* ■