

# Using Sonar for Navigation

By Steve Dashew

We spend a lot of time cruising in remote areas, where charts tend to be out-of-date or nonexistent. For years we've been thinking about using sonar for navigation in these situations, but it wasn't until Furuno sonar specialist Steve Bradburn started to tutor us in the possibilities that we got really interested. We were eventually convinced enough to install a Furuno CH270 Searchlight sonar aboard our 83 foot (25,5m) *Wind Horse*.



The sonar transducer is located 14 feet ((4.3m) back from the bow. Our canoe body hull type hull shape is quite shallow, so the transducer is immersed just 27 inches (700mm).

The comments and photos which follow are based on our initial impressions from using this gear.

## Principles.

Sonar works much like radar, only in water rather than air. The transducer emits a pulse of sound energy in a direction which the operator sets, and then waits for a return of sound energy bounced off objects in its path. The electronics convert these signals into images which are then viewed by the operator. Various factors affect signal propagation through the water (which we'll discuss later) and the shape and density of the targets dictate how well the signals are reflected back.

The harder the target, and the more nearly vertical it is, the better it reflects energy. The converse is also true. So targets which are angled away from you produce poor returns.

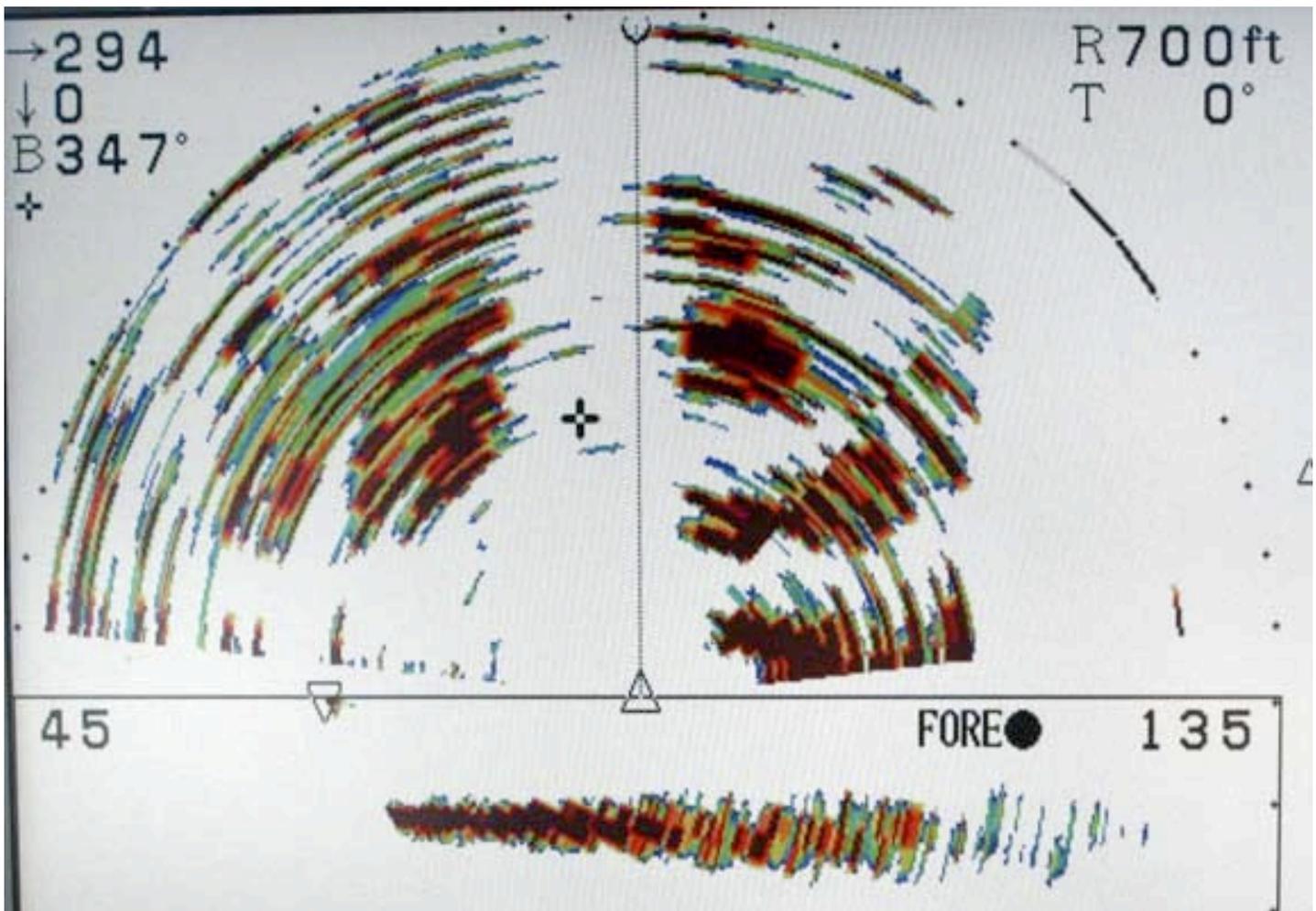
## Learning Curve.

Just like with radar there is a learning curve with sonar. What we know now, after just a few hours of practice, is that the basic system is quite user friendly. It looks like we are already operating at a level which gives us good functionality maybe 75% of the time. Getting to where we can efficiently use the system in difficult conditions is going to take some real world practice - just as with radar.

What we want to do now is give you a feel for where we are after a short period of practicing just the basics. We'll start out showing you what we have learned about using the system to work into a tight harbor or anchorage, where we are just feeling our way along at minimum speed.

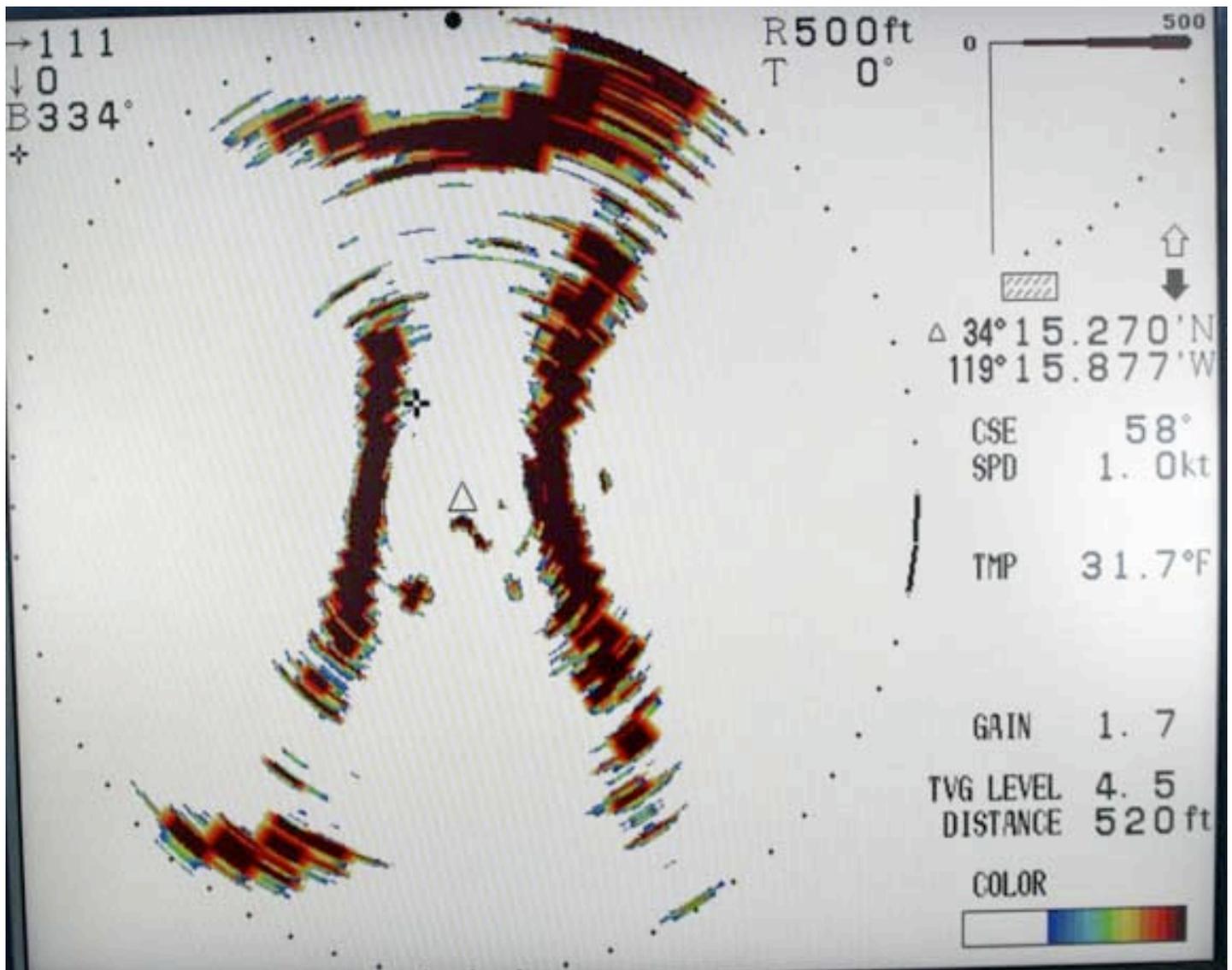
## Working in Tight Areas

Working into unfamiliar anchorages and along poorly charted channels is our primary reason for installing this system. We usually do this very slowly, feeling our way along, watching the sea surface for tell tale signs, allowing maximum time for analyzing navigation data now including sonar.



For best viewing distance ahead we use a horizontal view, with minimum tilt angle. We may also display at the same time a vertical slice through the water. The photo above shows a combined horizontal (top) and vertical (bottom) display. Or, we may go with just the horizontal display, as long as everything looks clear, using the vertical view if a target warrants further analysis. The two triangles represent the position of the transducer relative

to the screen image.



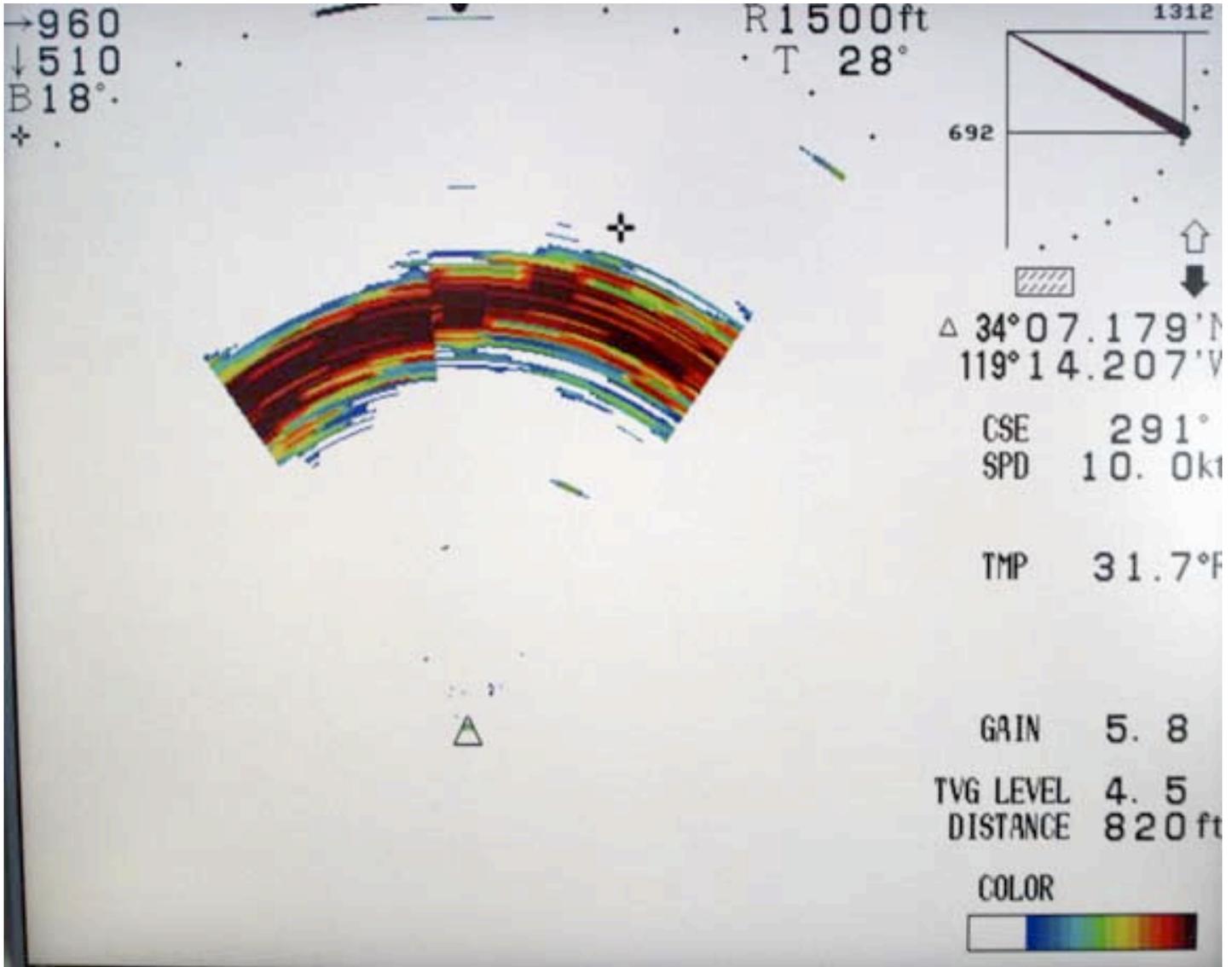
The image above is within the tight confines of a series of interconnected channels (see the photo below). The boat is barely moving as this photo is snapped. To help with situational awareness we've switched to a 360 degree horizontal view, so we see both sides and behind as well as ahead. The updating of the image is slower when we show this much view, but as we're barely moving this is OK (the faster we go the narrower we keep the sonar search sector to speed its update process). At the top of the sonar image is a channel bulkhead, with an open channel running to port. The same applies at the bottom port corner. You can also see a boat tied to the bulkhead on our port and what is probably a fish aft to starboard.



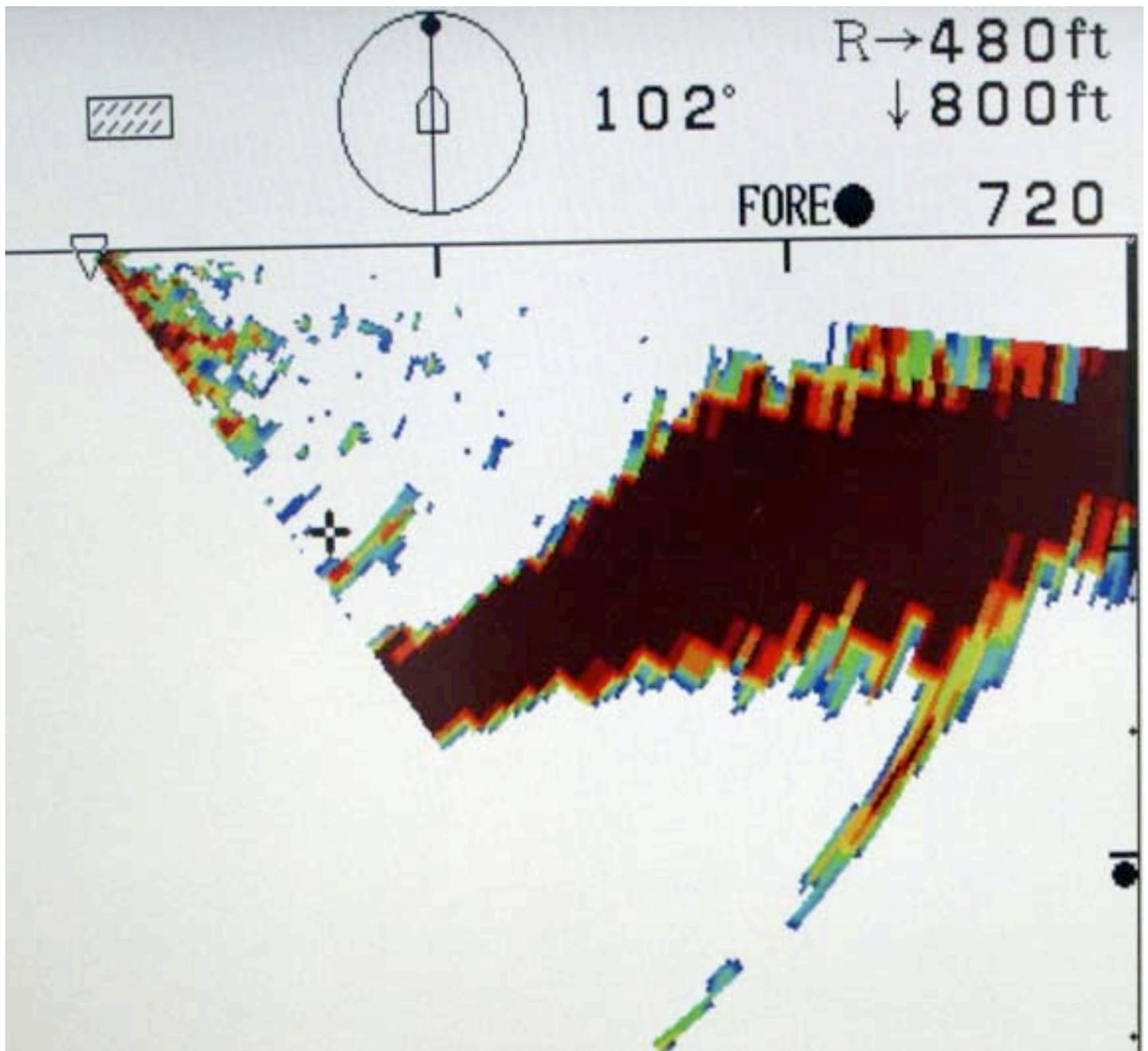
This photo was snapped a few seconds before the sonar image above. The boat which is shown on the port side of the channel in the sonar image is shown off our bow.

### Offshore Usage

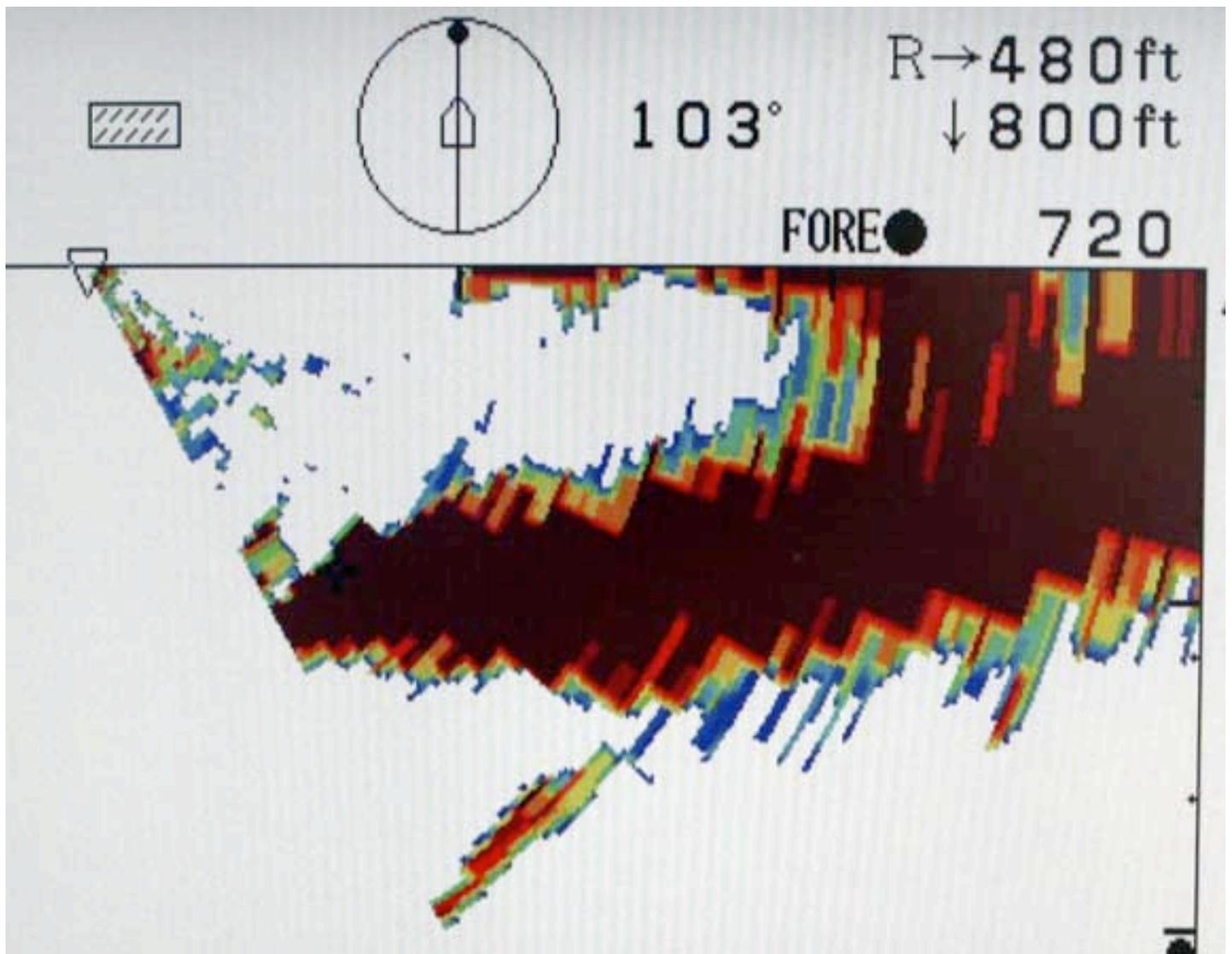
A different approach is used offshore where depths are apt to be deeper, vessel speeds higher, and surface turbulence often present.



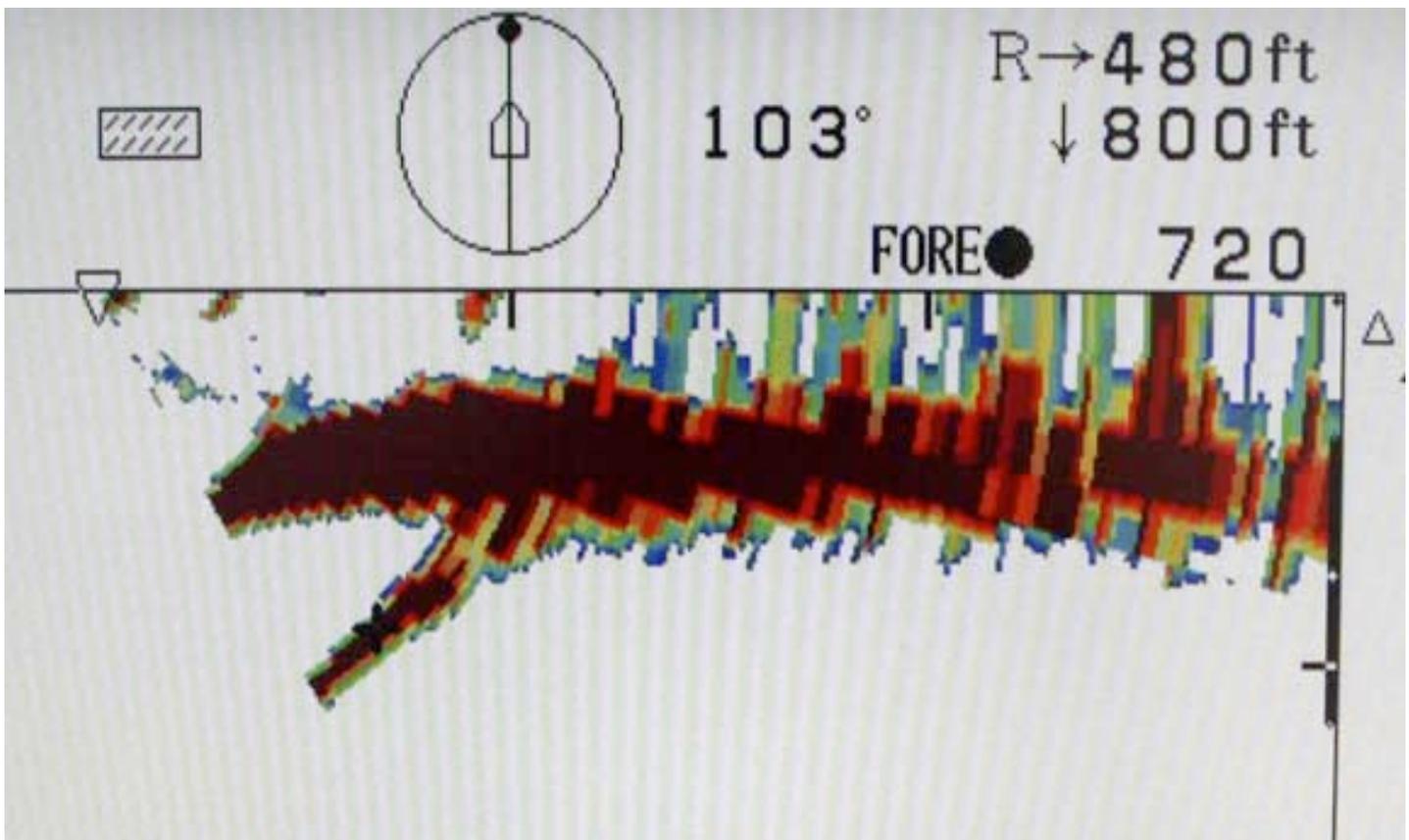
We were running at ten knots into four foot (1.2m) swells when this image was taken. The transducer is aimed down 28 degrees below the surface, and is set on a 72 degree sector (we've narrowed the sector to reduce the update time at this speed). The general principle here is to employ a tilt which gives a good bottom image at maximum distance ahead of the boat. In this case, with somewhat cloudy water, we've got a good target about 500 feet (150m) ahead. As long as there is a constant clear space ahead of us (the white area between the triangle and the red target), we know we're OK. However, if the red target begins to creep back toward the boat (triangle) this is an indication of shoaling water.



If there is anything suspicious ahead we can switch to the vertical mode (slowing down first of course) and have a look. In the vertical mode image above you can see the bottom is quickly shoaling. However, there is still plenty of open water ahead of us.



Here's the next photo in this sequence. From this image you would know there is a big question mark ahead in that solid mass of red. This might be a school of fish, or it could be a promontory or reef. So, we slow down even more until we've determined what we're seeing.



OK, the bottom has shoaled, but we've still got plenty of water below us. So, we pick up speed and proceed.

### **Audio**

When we're passaging, it is usually with just two of us aboard, and there is normally a single watch stander. That individual has to keep track of the radar, electronic charting, the engine room, plus a visual sea scan. Now that we've added sonar to the mix there is a lot going on. Given our ten- to eleven- knot speed, and offshore sonar ranges of 1000 to 2000 feet (300 to 600 meters) we've got somewhere between one and two minutes warning of something coming up from the bottom on the sonar screen.

Given the short time available to catch something on the sonar, if the only alert was visual, we'd have to keep our eyes just about glued to the sonar display. Given our limited man and woman power aboard, this is not practical on long offshore watches. This is where the audio output comes in. There is a discernible audio pattern to what is being shown on the sonar screen. We're finding that our ear becomes attuned to this in the background. Hard targets closer in are quite noticeable (in fact, fishermen have been making use of this feature for years). The audio output allows us to go about our normal watch keeping chores, with one ear open on the sonar speaker.

### **Viewing Breakwaters**

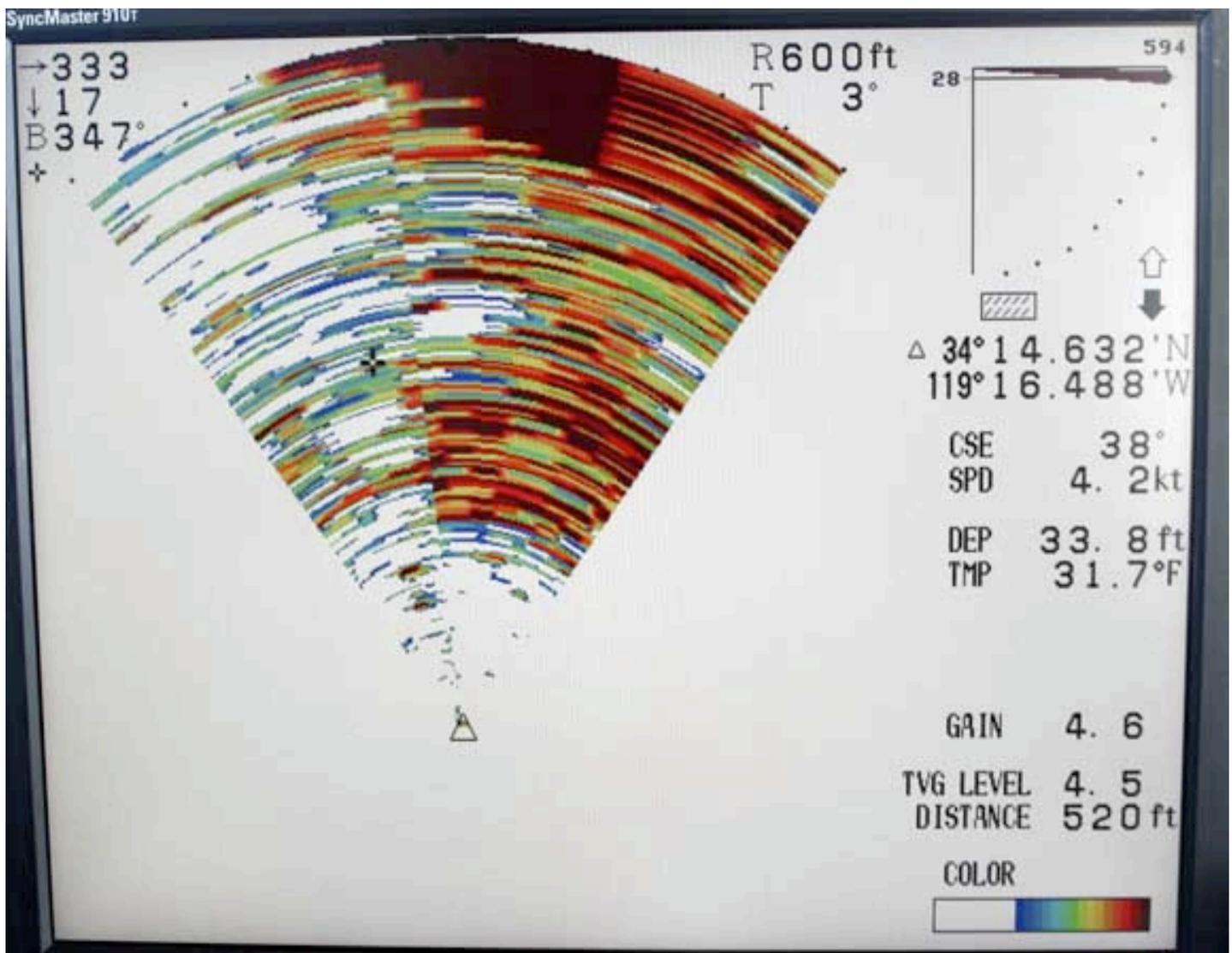
If there's a breakwater around the odds are we would not normally use sonar to view it. Radar would be a better option. But part of the learning process is to use the sonar to view known targets.

Breakwaters do not make particularly good targets. They have flat angles under the water which do not reflect sonar energy well, and they are often covered in turbulent water which

is heavily aerated and tends to absorb signal.



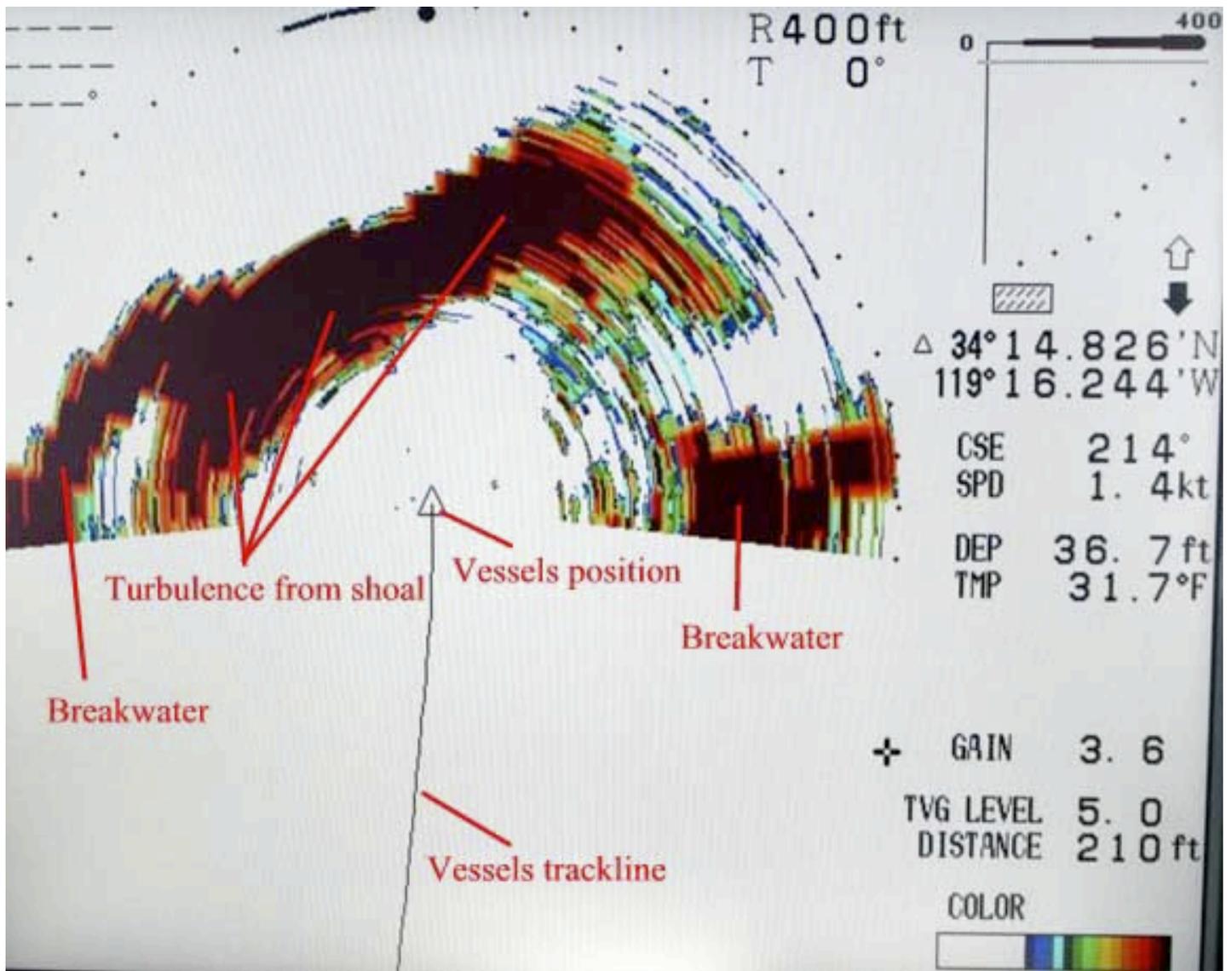
The breakwater in the photo above is parallel to the swells hitting it. Swells are averaging three to four feet (.9 to 1.2m). The water is also somewhat muddy, and there is a fair amount of marine growth present. None of this makes for good sonar viewing.



We start to get a solid return at about 600 feet (180 m). Of course we'd see this at a much longer distance with our radar, and know it was there with a chart plotter. But if this were a submerged reef with the only radar return coming from the surf - and then you add in rain squalls to block the radar return - this sonar image begins to look pretty good!

### Navigation Quality Control

With so many navigational tools at our disposal these days it is easy to become overconfident. We've got electronic chart plotters and wonderfully efficient RADARs to help us along. But mistakes are still made by experienced seamen, there are uncharted underwater obstructions, and errors on the charts themselves. What we like about our Furuno searchlight sonar is that it gives an additional factor of safety against the mistakes which can (and do) happen. Where we might miss an underwater obstruction on our electronic charts (especially if we're tired), odds are we'll see it on the sonar.



Take the sonar image above. The entrance and exit of Ventura harbor in Southern California has claimed many boats over the years. There are a series of breakwaters, shoals, and sand traps, and it is easy to become disoriented. Add to this the changing nature of the shoals, and you can see why this is not the best place to enter without local knowledge and reasonable navigational conditions. The chart plotter and radar won't show us the ever changing shoals around these breakwaters.

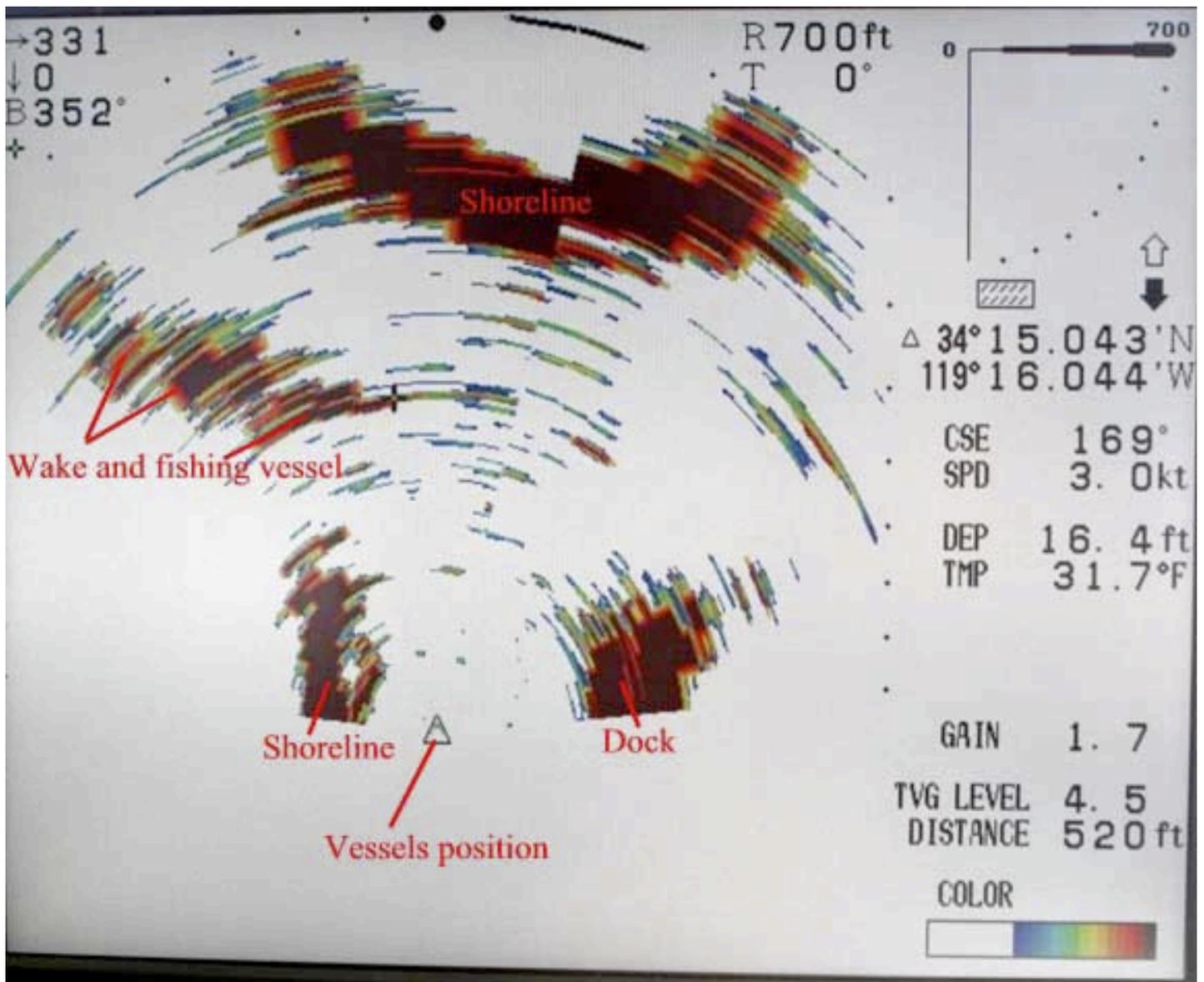
But the sonar image is showing us that we're headed for something very firm and shallow. It is also showing us that there's an opening off our starboard beam.



This photo is taken about a minute later. You can just see the north edge of the breakwater extending from the beach. If you look carefully, you will see a sea surface disturbance extending from the breakwater. This indicates the shoal which is shown on the previous sonar image.

### **Wake Turbulence**

Wake turbulence - our own or that of other vessels will create a hard target and or block all images for a period of time.

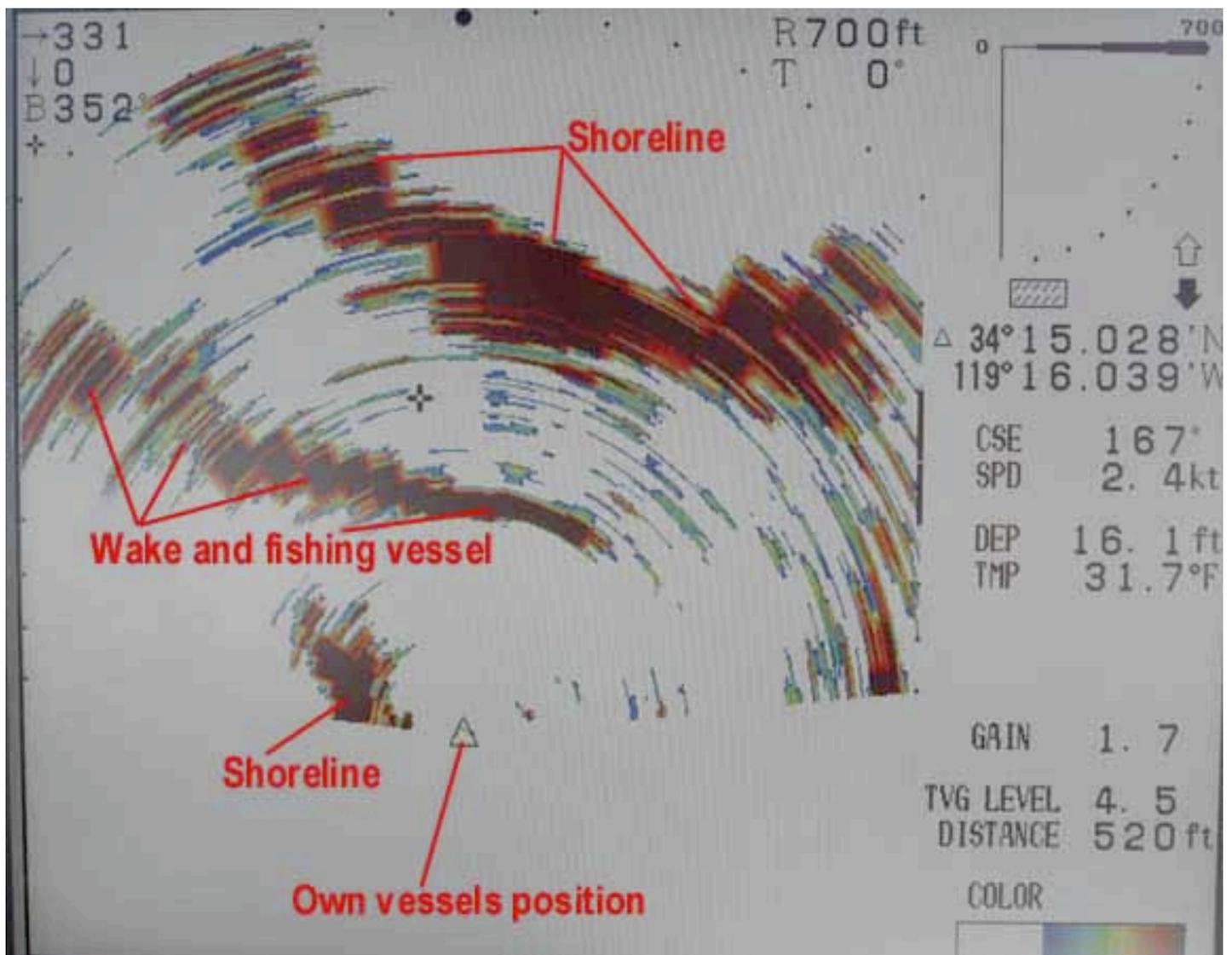


In this image you can see the shore on either side of us, and directly ahead. Half way up the screen and to the port is another hard looking target.

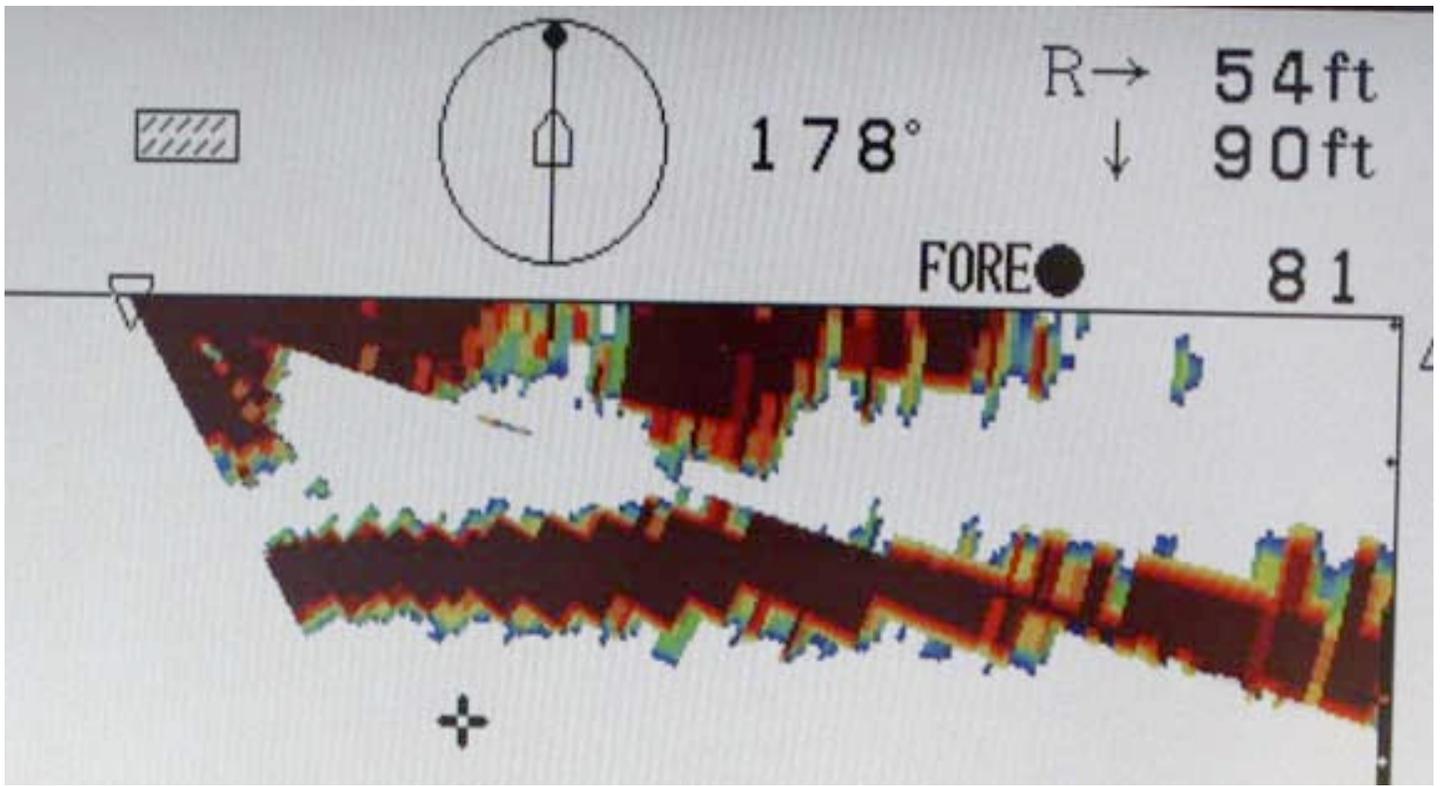


This photo will put things into perspective. The fishing boat about to cross our bow is what is

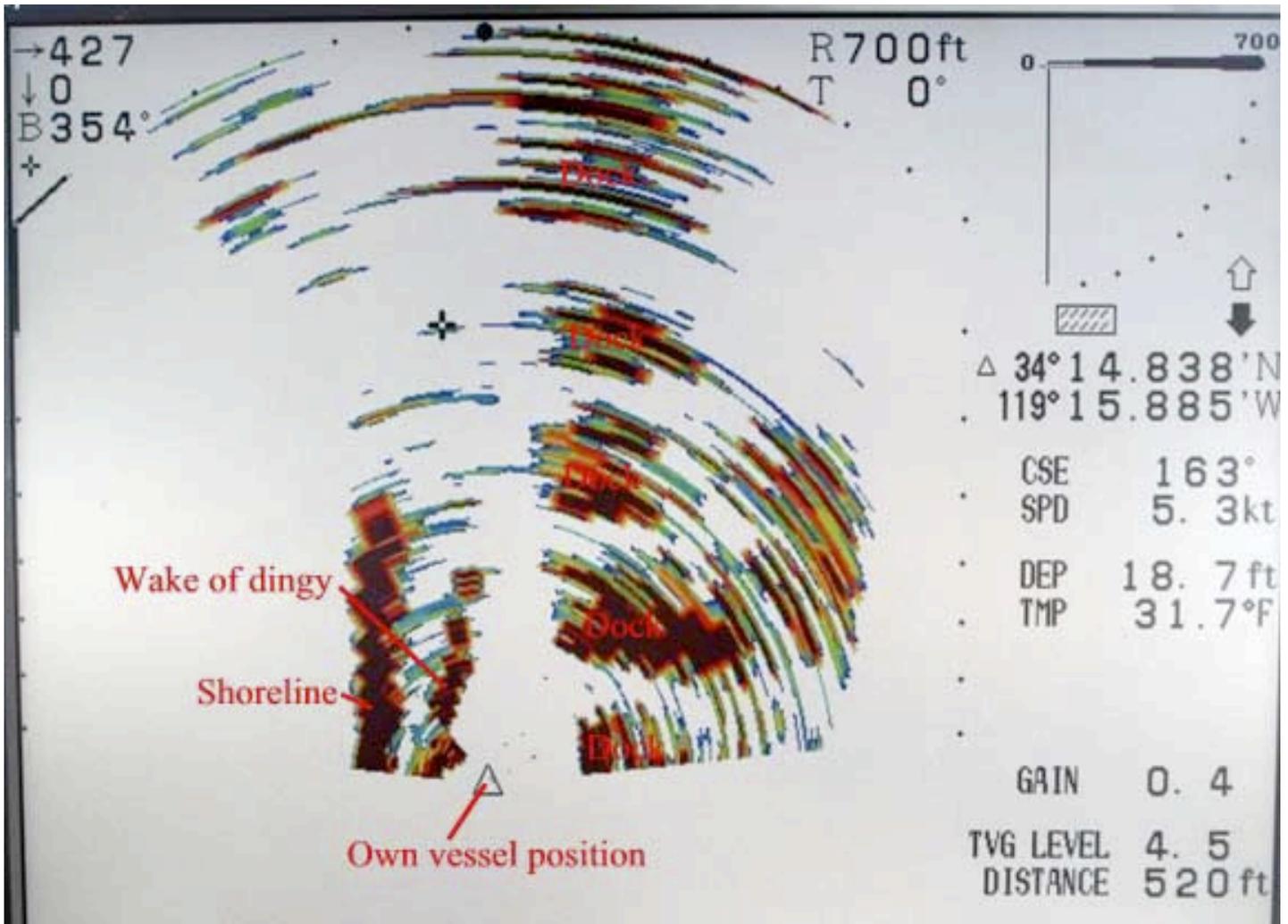
causing the target to port - both its hull and its wake.



And now another sonar image taken a few seconds after the photo. You can now see the wake trailing behind the fish boat, and the well defined hull crossing our bow. In the real world, we'd see this vessel on radar, note its running lights, or have a visual day time contact. The main point is the wake, which is going to disturb our ability to see anything within this disturbed area of water for a period of time.



We can check the horizontal image further by switching to the vertical view. This shows us the horizontal target we've been looking at is not connected to the bottom. This might lead us to believe that there was no problem, but this could be a dead head (vertical log) which we would want to avoid!



Wake turbulence is a function of the power being applied to the water by the prop pushing the vessel in question, the depth of the vessel and the prop, and the depth of the sonar transducer. In our case, with a shallow forebody the transducer picks up even dinghy wakes, like the one shown above. A deeply mounted transducer would probably not show this wake.

## **Own Ship's Wake**

We did a series of tests to get a feel for the conditions in which our own wake might cause a viewing problem and how long this would take to clear. We were running at idle on one engine, about three knots boat speed. Very gradual application of reverse would not create a major viewing issue. However, using both engines for an immediate stop (from three knots) created enough turbulence that the sonar would be blind for three to five minutes. Should this occur in a difficult situation, the answer would be to hold station until clearing had occurred, or carefully retrace our inward track and wait the required time.

## **Other Masking Factors**

As with radar, there are factors which can reduce the visible range of detecting underwater obstructions or totally hide underwater targets from sonar. These include:

Aerated water from waves or as previously mentioned, wakes. In the case of shallow spots with waves breaking on them, this can cause loss of signal or generate an extra strong signal.

Heavy concentrations of marine micro organisms reduce sonar efficiency. This can be tuned out to a degree using sea clutter. Range is always reduced in this situation.

Muddy water, from wave action, or river run off reduces sonar efficiency.

Major temperature changes (thermoclines) will hide targets (submarines make an art of hiding this way).

Fresh water lying on top of salt will give you a good image through the fresh water, but the fresh to salt water interface will often hide what lies below.

All of which is a reminder never to totally depend on any single source of navigation data, including sonar.

## **What's Next?**

We've learned enough in these initial sea-trials to know our sonar is going to see a lot of use for navigation. Initially it will be with known targets - harbors, anchorages, and coast lines with which we are familiar. We feel now that it will quickly become a valuable double check against operator error of our other nav systems. Once we become a little more familiar with interpreting the images we will begin to use the sonar to work into anchorages we might not otherwise visit.

**About the Author:** Steve Dashew is a yacht designer and the author of eight books. More than 250 of his articles have been published in yachting magazines around the world. His weekly reports can be viewed at [www.SetSail.com](http://www.SetSail.com).