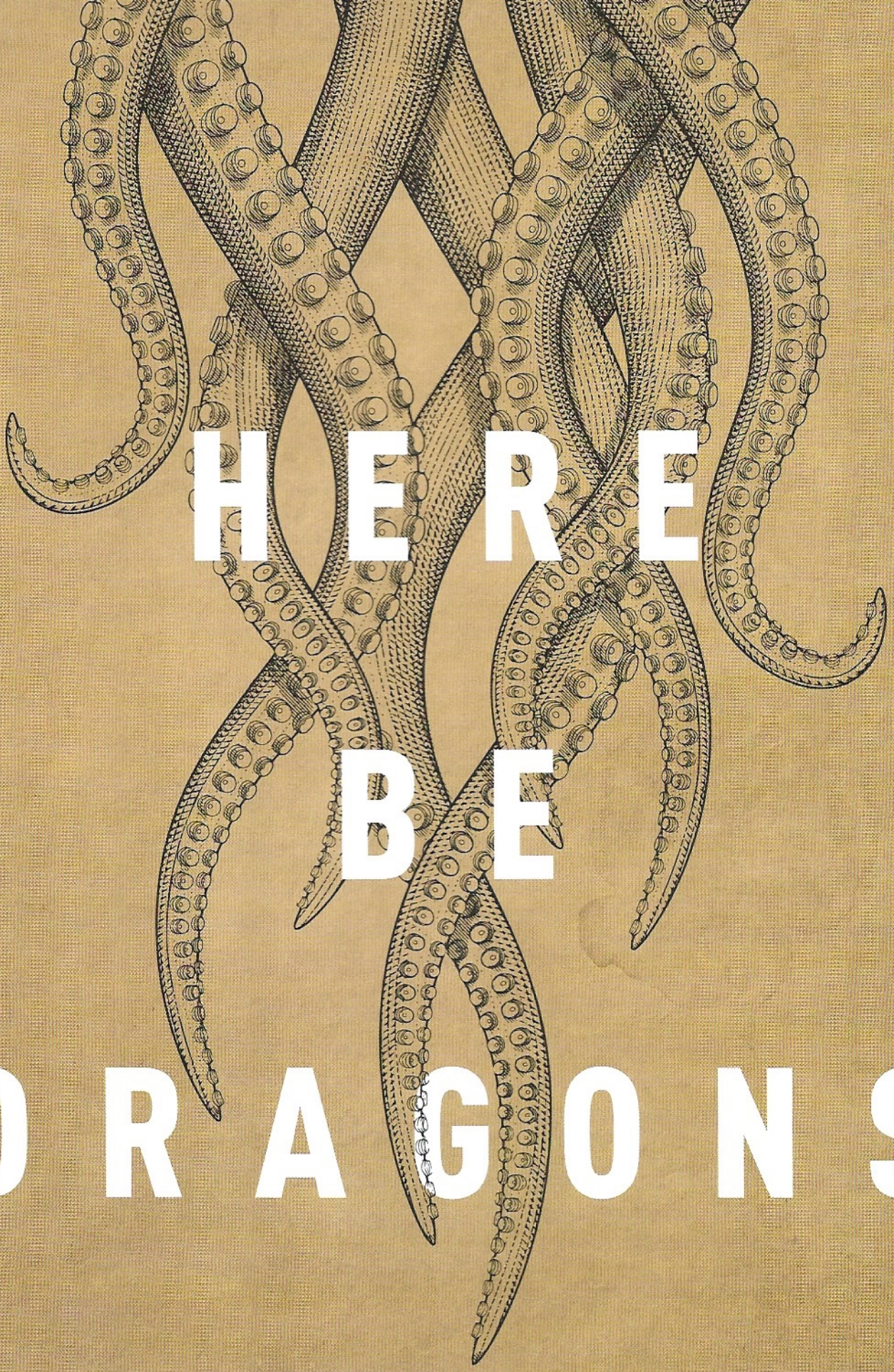


HERE BE DRAGONS

Superyacht owners are exploring increasingly remote corners of the globe, but many oceanic charts are staggeringly out of date. *Sam Fortescue* investigates the navigational perils of intrepid cruising

Running aground has to be near the top in the pantheon of nightmare scenarios for yacht captains. Being at the helm when the boat is damaged and inducing the guests to spill their drinks is bad enough. But the mauling to the skipper's reputation can be even worse. Careers have been fatally holed below the waterline by less.

And yet we are in the grip of a growing trend for explorer yachts and holidays off the beaten track. Every yard building yachts from 20 metres up is urging us to stop quaffing vintage Krug on the Côte d'Azur and go adventuring. And as more owners follow the call, their crews have to grapple with the fringes of our watery world. In more remote areas there is almost no chart detail at all when you inspect the Electronic Chart Display and Information System (ECDIS), and in many others, the scant survey data available dates back more than a hundred years. Not everyone understands what they're looking at.

"Many yacht guys aren't commercially trained," says Steve Monk with a sigh. He is an ex-Royal Navy navigator and now trains yacht crews in the finer points of navigational safety with Da Gama Maritime. "They look at the ECDIS and see a computer with the latest chart. They assume that all the information around them is top-notch. They mistakenly think that an up-to-date chart means it was surveyed yesterday."

He tells the story of a yacht that grounded off Madagascar. "It was in an area where, if they'd bothered to look at the chart and interrogate it, there was no known datum and the survey data was just ancient," Monk says. "The paper chart pretty much had pictures of sea monsters and dragons and signs saying 'don't go here'." He says that navigators are forgetting the lessons of thousands of years and putting blind faith in their electronics. "They were 1,500 yards [1.4 kilometres] away from where they thought they were. It damaged the hull and nearly pushed the prop up. They got very lucky."

The notion of navigating someone's multimillion-pound toy into a bay, relying on depths obtained in the 19th century by researchers hefting lead lines, should make you uncomfortable. But it would make you feel a lot more uncomfortable if you knew that you don't have to go far off the beaten track at all to encounter this problem.

Monk shows me a screenshot of his ECDIS simulator, and zooms in on the Côte d'Azur. The view comes to rest on the coast around Monaco, bristling with tiny green "U"s. "A 'U' in a box shows the area is unsurveyed," he explains. "Just off Monaco, the data is from 1978 to 1986. Even a few miles outside

58%
of British waters are surveyed to modern standards (UK Hydrographic Office)

54%
of US coastal waters are surveyed (National Oceanic and Atmospheric Administration)

20%
of the world's ocean floor is mapped (Seabed 2030 Project)

Right: nuclear submarine USS San Francisco struck a seamount 675km off of Guam in 2005 while operating at full speed at a depth of 160 metres. The seamount did not appear on the chart in use at the time. The submarine's bow replacement was estimated to cost $79 million

Monaco, yacht skippers assume that because it's deep, it's well and recently surveyed."

Scale back until you get a view where the detail is considered acceptable (denoted by a star rating between two and four) and you can see much of the French Mediterranean coast. "It's like looking at a map of the English Channel and trying to navigate into the Lymington River," Monk adds. Captains must use their own judgement to decide what level of detail is acceptable, because flag states want the liability to remain on board.

The waters off Monaco are no mere blip or a chink in the survey data. The UK Hydrographic Office reckons that only 58 per cent of British waters are surveyed to modern standards. And a recent estimate by the National Oceanic and Atmospheric Administration (NOAA) in the US found that just 54 per cent of its coastal waters were adequately surveyed. "And that's with all our resources and our survey vessels," says Jennifer Jencks, a physical scientist with NOAA and chair of the International Hydrographic Organisation's (IHO) Bathymetry Working Group. "Alaska is only 20 per cent mapped and the Great Lakes are only five per cent. How have we managed that?"

Globally, the picture is far worse. Just 15 per cent of the ocean floor was mapped in 2015, and today that stands at a mere 20 per cent, according to the Seabed 2030 project. Funded by UNESCO, the IHO and Japan's Nippon Foundation, Seabed 2030 is aiming for 100 per cent mapping by the end of the decade. Before you breathe a sigh of relief, though, understand that "mapped" means soundings at 800-metre intervals offshore, with 100-metre centres in coastal areas. Think how much topography could be lurking just below the water in a 100-metre stretch of sea – even within 800 metres of open ocean.

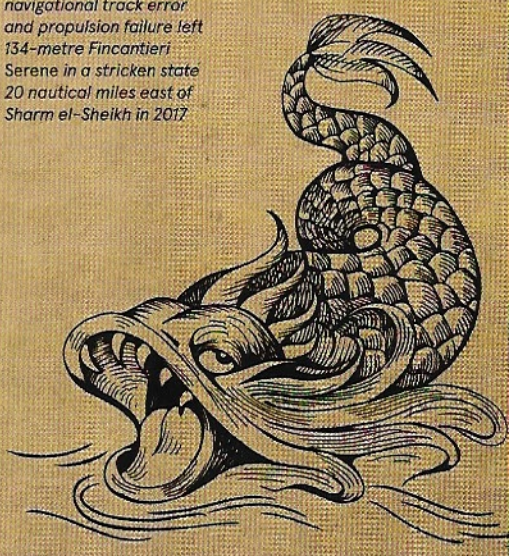
It is a lesson that the USS *San Francisco*, a 110-metre nuclear submarine, learned to its cost in 2005 when it "discovered" an uncharted seamount at 30 knots near Guam in the Micronesia region of the Pacific Ocean. The vessel came to a total halt, crashing 160 metres down, and its 127 crew members were thrown across their cabins by the impact. Tense minutes passed while the engineers tried to create buoyancy, then the sub slowly began to rise. It took 52 hours to limp back to Guam with a 10-metre section of its bow crushed like wastepaper. "It was just assumed that if surrounding depths were significant, it would all be like that," says Monk. "But it isn't – the planet isn't like that."

Closer inshore, 60-metre *Ice Angel* (ex-*Cloud 9*) struck an uncharted pillar of rock in south Greenland and had to be abandoned. She was sailing at 14.5 knots in an area with no known soundings. Less dramatic, perhaps, but still extremely costly, is the case of the 134-metre Fincantieri *Serene*. Fresh out of refit in 2017, she was pictured hull-up on a popular diving reef about 20 nautical miles east of Sharm el-Sheikh. The cause of the accident, estimated to have cost the owner tens of millions of pounds in salvage and repair, was reportedly a navigational track error coupled with propulsion failure.

After the accident, images of the stricken yacht appeared online, then quickly disappeared again. Such is the embarrassment and legal fulmination around groundings that very few reports ever make it back to hydrographic offices. "This is my biggest bugbear in this industry: we don't talk about it, so we can't learn the lesson," says Monk. "If they don't report it, the charts are never going to be corrected. This is a massive failing of the superyacht industry, and it's chilling for safety. It will take people dying before any action is taken, then it will be a knee-jerk reaction."

Not everyone adheres to this culture of silence. Captain Christoph Schaefer is quite open about the two groundings he had in former commands. "The first was in a 100ft [30-metre] boat in the Sea of Cortez, south of Isla Tiburón," he tells me. "There was a small off-lying island and our cruising guide was vague about whether to go north or south about. I went south and promptly ran aground. The authors of the guide had never been there and provided the wrong information. Luckily, the bruise to my ego was much, much bigger than that to the boat."

The other incident came later, and on the other side of the planet, near the Indonesian nature reserve of Tanjung



Opposite page: a navigational track error and propulsion failure left 134-metre Fincantieri Serene in a stricken state 20 nautical miles east of Sharm el-Sheikh in 2017

Puting. By now he was captain of 74-metre Freire *Pegaso*. With the mandatory local pilot on the bridge, the yacht ran into a sandbank navigating into a river mouth. "I told the pilot to sit down, got him a cup of tea and told him to shut up every time he tried to open his mouth," Schaefer says. "Then we put the tender back in the water and surveyed the channel ahead."

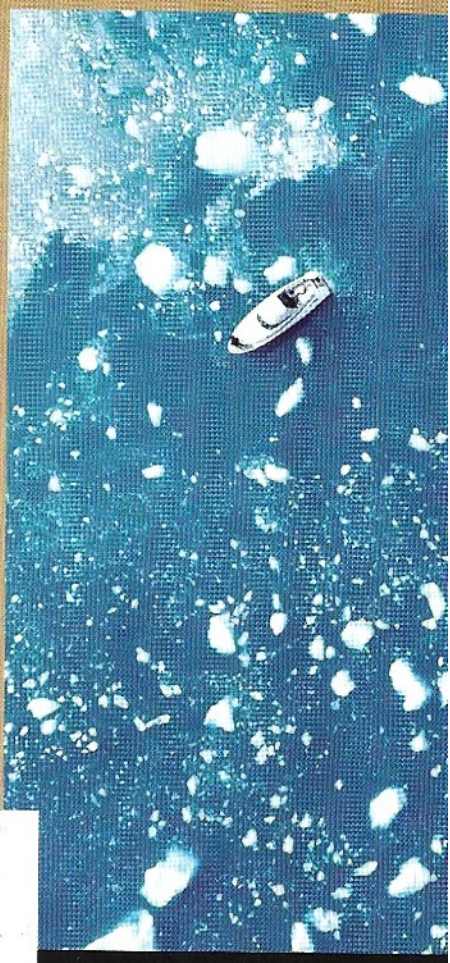
UNOFFICIAL DATA

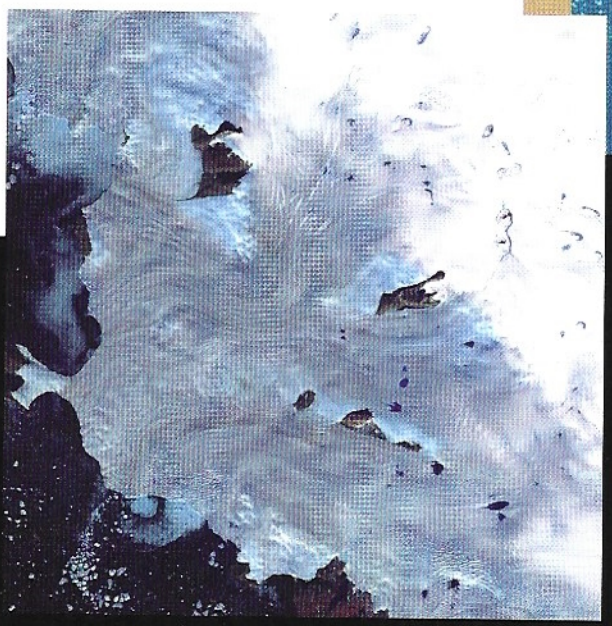
If you can't rely on charts or pilots, what do you turn to? Perhaps surprisingly, Schaefer says his first port of call was Google Earth, which proved a revelation with its incredibly detailed satellite imagery. "Suddenly we could get a pretty good idea of what is out there," he enthuses. "It is mainly useful for the tropics, where you have the sun directly overhead and relatively clear water to give light penetration below the water where you can see rocks." These days, the rock he found in the Sea of Cortez even shows up on Apple Maps.

It's a trick used by skippers of boats large and small. For the dedicated and parsimonious skipper, free GE2KAP software developed by Paul Higgins will match up precisely geo-coded images from Google Earth with the corresponding charts on the Open CPN navigation platform. It's easier for big-budget yachts with a broadband connection. By connecting a GPS device to a laptop or tablet, Google Earth will show your position in real time. Schaefer has a dedicated display for this on his bridge.

Satellite images are less powerful at higher latitudes, however. Low sun and poorer detail is partly to blame. And global heating is melting ice so fast that it is changing the coastline. During an expedition to Greenland on 55-metre Amels *Kamalaya*, Schaefer found himself navigating well inland according to the ECDIS. "The retreating glaciers open up new and not-yet surveyed fjords. The system showed us a quarter of a mile inland, high and dry, and yet we were a quarter of a mile from the glacier's front, still in around 50 metres of water."

Here you need other tools. Besides a good dose of paranoia and caution, Schaefer swears by a sonar array. He uses the New Zealand-made WASSP system, whose multiple beams





GROUNDED IN GREENLAND

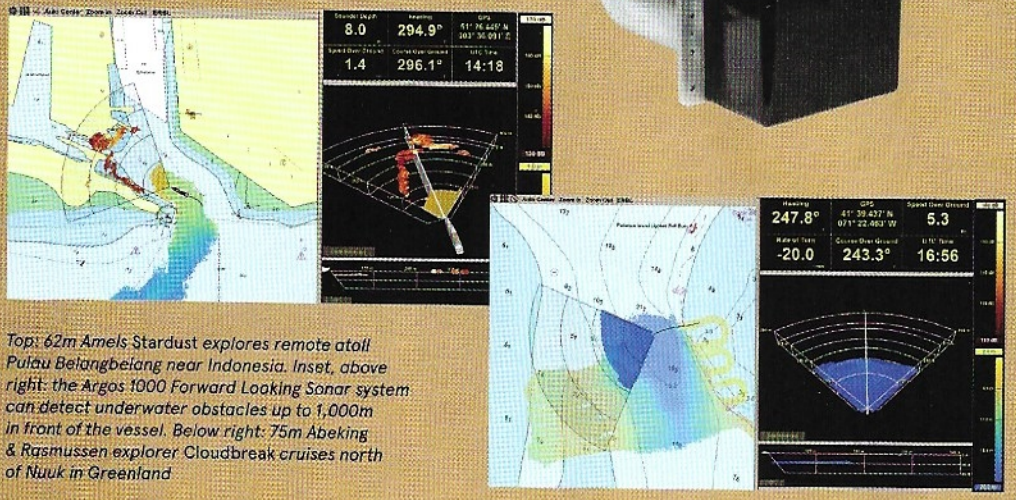
Shortly after 7pm on a fine September evening, the owner, guests and crew of 60-metre *Ice Angel* (*pictured above right*) were thrown off their feet as the boat came to a shuddering halt. "Very loud" banging and scraping noises were heard, and she quickly adopted a 15-degree list.

Alarming enough anywhere, the situation was made more perilous still by the fact that the yacht was navigating in a remote area close to Cape Farewell, on Greenland's southern tip. Despite the fine conditions and calm sea, the air was a mere five degrees Celsius and the sea near freezing. By the greatest of good fortune, the nearest town of consequence was just 29 nautical miles distant.

Only a little water was discovered in the bilges and all the guests were successfully evacuated ashore in the yacht's tender. After listing to 40 degrees, she floated free on the tide the next morning and could be towed to safety with one generator operating the bilge pumps. Damage included water ingress, cracks to the hull, detached stabiliser fins and keel damage. Deemed unseaworthy, the yacht had to be carried back to the UK on a heavy lift ship.

The subsequent investigation established that the yacht had cut through a 500-metre wide channel between the mainland and an off-lying island, where there were no soundings. Greenland Chart 1103, in use at the time, warned that differences between the paper chart and GPS positions might be "significant to navigation" while inshore soundings were of a "reconnaissance nature" only. It urged due caution. Earlier during the day, the yacht had deviated from her planned course and speed several times, with a 24-nautical-mile diversion added to the passage plan.

The *Polar Water Operational Manual* urges "abundant caution and total aversion to the risks of grounding" in such remote sea areas. It adds that this will require a change of mindset from that adopted on normal operations. The accident report concludes that this change did not occur.



Top: 62m Amels Stardust explores remote atoll Pulau Belangbelang near Indonesia. Inset, above right: the Argos 1000 Forward Looking Sonar system can detect underwater obstacles up to 1,000m in front of the vessel. Below right: 75m Abeking & Rasmussen explorer Cloudbreak cruises north of Nuuk in Greenland

CROWDSOURCING DATA

Alarmed by the weak survey data in large parts of the world, and by the growing number of yachts heading off the beaten track, the IHO has set up a system to crowdsource depth data. The NOAA's Jennifer Jencks is at the sharp end of this operation, which is a titanic exercise in hoovering up and verifying data. "We're talking to fishermen, cruise lines and superyachts," Jencks says. "Everyone has a big role to play. Then the IHO can decide on the role of this data. Is it an anomaly that needs more investigation, for instance?"

Farsounder says it has 11 yachts recording data onto USB sticks under its Expedition Sourced Ocean Data Collection programme. In this way, it has already fed the IHO with more then 30TB of soundings data from Baffin Island to the Antarctic Peninsula. But you don't need any special kit to contribute, and Jencks is urging superyachts to take part.

Captain Michael Mann of 77-metre Feadship *Pi* uses a simple USB data logger connected to the instrument system. "All the kit was supplied to us and then installed by our engineers on board," he says. "Because there is no connection to the internet and the USBs are supplied by ourselves and formatted before being plugged in, we feel there are no security concerns."

Pi has already delivered valuable data from cruising Costa Rica, the Galápagos, the Bahamas and Greece. "Over the next year or so we plan on heading back to the Pacific for cruising in the Sea of Cortez, Costa Rica and possibly Patagonia before continuing westwards into the South Pacific islands," says Mann. "Anything that we are able to gather and gets used to improve knowledge of depths benefits others and also ourselves when we return to those areas." ■

Superyacht owners can contribute to the IHO's Crowdsourced Bathymetry initiative by emailing bathydata@iho.int

SURVEYING TECH

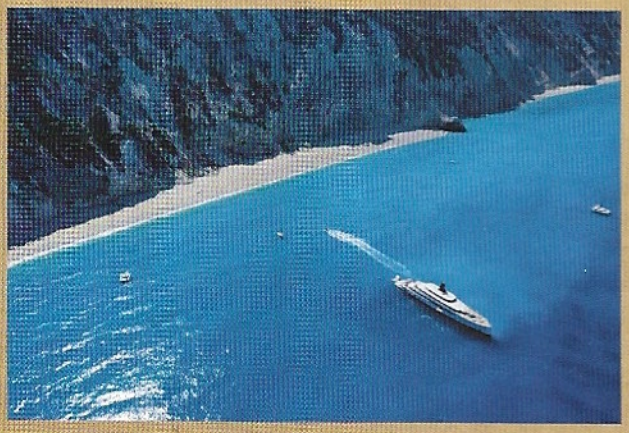
The simplest surveying kit amounts to a data logger the size of a smartphone. It plugs into your instrument network and records the time, depth and GPS position. They can be bought for as little as £40 and require no specialist installation.

For better surveying capacity, you'll need more than standard single-beam sonar, which only tells you the depth directly beneath the boat. Leisure brands such as Garmin and Simrad manufacture capable CHIRP sonar systems that generate a 3D image of the seabed around the boat. Both brands are capable of storing user-generated data and sharing it with others, but you can only view it on their own proprietary platforms. Costs for the sonar unit and display amount to £2,000 to £5,000.

For big-boat systems that are compatible with MaxSea TimeZero navigation software, you'll need a beefier transducer. WASSP offers just that, with a price tag of $35,000 to $60,000. Mount it on the tender and use it to survey a wide swathe of the seabed beneath the boat. WASSP can measure down to 1,000 metres and covers a breadth of 3.5 times the depth. It sends real-time data up to two kilometres back to the mothership by Wi-Fi.

Furuno's Searchlight Colour sonar (*pictured below*) is like an underwater radar that determines the bottom profile in a wide circle around the boat. Significant calibration and user training are needed.

Farsounder's system is more complex and costs up to $180,000. Its transducer paints an image of the seabed up to 1,000 metres ahead of the boat along an arc of 60 degrees. Farsounder offers yachts the option of sharing the bathymetric data gathered. With WASSP it is harder, although there is a workaround if you share its data using specialist surveying software.



Above: navigational aids in the bridge of V6 as the boat negotiates the waters around Lilliehöök Glacier in Svalbard. Left: 55m Amels Kamalaya exploring waters around the Magdalena Fjord glacier in Spitsbergen, a Norwegian archipelago in the Arctic Ocean. Below left: 77m Feadship Pi cruising off Greek island Lefkada in the Ionian Sea. A satellite image of the Monaco coastline

scan a 120-degree arc under the boat to build up a 3D picture. Mounted on a tender which goes on ahead, the system can scan an anchorage in the time it takes to drink a cup of tea and send the data back to the mothership. He couples this with a Furuno Searchlight scanner, which casts a sonar beam up to 1,000 metres ahead of the boat to look for obstacles (or fish).

An alternative is the American-built Farsounder, which gives you a sonar picture of the seabed up to 1,000 metres ahead. Fitted to the mothership, it is a six-figure investment and the boat needs to be hauled out for installation, but it works at speeds of 20 to 25 knots. "Our systems are designed to map the sea floor in 3D out to a range of at least eight times the depth of water below the transducer module," says Matt Zimmerman, Farsounder's executive vice-president of engineering. "However, even in shallow water, they can detect in-water obstacles out to the full range of the sonar. We have had a number of customers report that they can see large whales with the sonar."

Detailed satellite images, such as this one of the Betsiboka River in Madagascar, are highly useful navigational tools