

1. Ship Without a Rudder

November 2, 2016 Marc Hughston

This older article from Cruising World gives some informative lessons about how sailors can manage the ship when they've lost the rudder.

Scroll down for the article



HANDS-ON SAILOR

Practical solutions and techniques for the bluewater sailor

SEAMANSHIP BY HERB McCORMICK

Ship Without a Rudder

When the sleek, 60-foot racer/cruiser *Serengeti* lost her steering while weaving through the Bahamas en route to Jamaica during last winter's Pineapple Cup, cool heads prevailed, and hard lessons were learned

IT'D BEEN A BOUNCY, WET, exhilarating 13 hours since we'd answered the starting gun off Fort Lauderdale last February 4 to begin the roughly 800-mile race to Jamaica in the 2005 edition of the biennial Pineapple Cup (formerly known as the Miami-Montego Bay Race). Aboard *Serengeti*, an exquisite 60-foot sloop owned and skippered by veteran sailor Chad Weiss and designed by naval architect Bill Tripp, things seemed to be shaping up nicely.

We'd bolted across the Gulf Stream in bumpy but blistering fashion and had already put the Bahamian waypoints

of Great Isaac and the Berry Islands astern. Now all we had to do was round the north end of Eleuthera island, hoist one of *Serengeti's* big kites, and ride the steady, 20-knot-plus northerly south with all dispatch. Forecasters predicted the potential record-setting conditions would hold for several days. *Serengeti* was sitting pretty.

It took but a split second for it all to unravel.

Regular *Serengeti* crew-member Joe Nanartowich was at one of the yacht's twin wheels when he heard "a little ching." The boat rounded up instantly, and instinctively,

Nanartowich swung the helm down hard to correct his course. But the spokes spun round and round like TV's Wheel of Fortune, and *Serengeti's* ensuing "auto-tack" and wipeout were nothing less than spectacular.

In every sailor's life there's a first time for everything, and I count myself extremely fortunate that my first lost rudder at sea was experienced aboard a well-equipped oceangoing sailboat with a highly skilled team ready for anything. So, despite the fact that our promising race was finished, not all our luck was bad. Indeed, the rudder vanished in



In the early going, *Serengeti* briefly set a spinnaker (left). This image—above the chart plotter (above) shows where the rudder vanished and the abrupt right turn for Nassau. Owner Chad Weiss (below) keeps an eye on the Sea Claw drogue, at this juncture properly submerged.

geti is a high-tech sailboat sporting a lifting keel and carbon rig, items that have served her well in such offshore races as Newport-Bermuda. But she's also a true dual-purpose boat, with a handsome, functional interior laid out for the family cruising and occasional living aboard that owner Weiss also enjoys.

When we left Florida, however, the boat was in full racing mode, her saloon stacked end to end with spinnakers and headsails, her crew a dozen strong. With temperatures in the 60s F, it was no beach day in Fort Lauderdale, but we weren't headed to the beach. Instead, the Gulf Stream beckoned, its western edge a good 15 to 18 miles offshore. With a full main and jib, we made quick work of that and were soon bounding across the roiling, rollicking Stream.

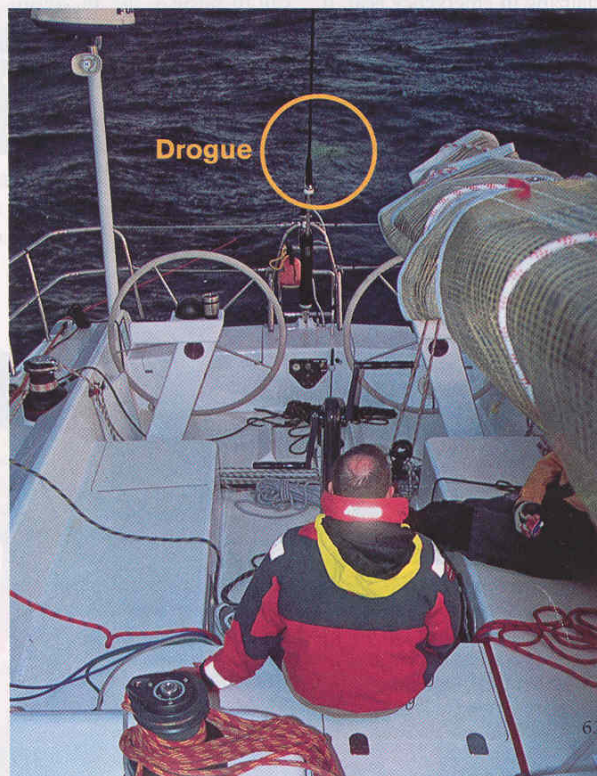
Scrawling notes in my sodden notebook, I recorded the usual early-race mayhem: a couple of headsail changes; a brief, regrettable attempt at flying a spinnaker; back to a small jib and a reefed main. It was my first trip aboard

Serengeti, but the consensus among the regulars was unanimous—cranking along at anywhere from 12 to 15 knots, we were hauling the mail. I was perched forward on the weather rail, and it was a wet ride; we occasionally shipped some solid water. My world was especially rocked by one hurtful wave that very literally knocked the wind out of me, another first (and I hope a last).

I went off watch at dusk and was back on at midnight. Overhead, the thick sky was beginning to break up, and the odd star began to shine

through. The worst of it was behind us. But the sailing was still very challenging, with the wind shifting steadily through 25 degrees in the lulls and the puffs, and it was imperative that the main-sheet trimmer and driver work closely together. I handled the main for a while and Tripp steered, and we began to sense what the other was about to do without speaking. In the big gusts, I eased the main way off as Bill bore away; once or twice I even had to press the “panic button” that blows the hydraulic boom vang to keep us on our feet. After a bit, it occurred to me that I was thoroughly enjoying myself.

At 0300, the watches changed again. Twenty minutes later, I was down below chatting with seasoned navigator Jack Harvey—who'd done the race at least eight times (that he'll admit to) and could never remember not beating out through the Bahamas—when suddenly we heard Nanartowich cry, “No helm!” *Serengeti's* swift race turned into something altogether different.



the deep, unobstructed waters of Northeast Providence Channel, not along the lee shore of a coral-fringed island (which would have been the case a couple of hours later). And among the crew was Bill Tripp himself, ready and willing to tackle the question any sailor in such a predicament would ask: “Now what in the world would the designer do?”

But I'm getting ahead of the story.

Fast Break from Florida

Built in New Zealand at Marten Marine of a composite blend of aramid and E-glass over a PVC core, *Seren-*

HANDS-ON SAILOR

Detour to Nassau

Chad Weiss was forward trying to snatch some sleep, and Bill Tripp was aft discussing strategy when we lost steerage. Since the “ching” we’d all heard didn’t sound catastrophic, they thought—as did I—that something was remiss with the steering quadrant, possibly a snapped line or a broken block that could easily be jury-rigged or repaired. But upon inspection, it was discovered that the carbon rudderstock had broken free and clear precisely where it exits the hull, carrying the attached blade with it. Happily, we didn’t take on even a spoonful of water.

Navigator Harvey instantly noted our position and quickly assessed our immediate options. And there was Nassau, 40 miles south, dead downwind. All we had to do was get there. There was no shortage of opinions on how that task might best be executed.

Owing to her New Zealand heritage, *Serengeti* carried an unusual drogue called a Sea Claw from Coppins Sea Anchors (www.paraseaanchor.com), a Kiwi company specializing in emergency gear. It was immediately deployed and for most of the time did a reasonable, though not exceptional, job of keeping the stern to the wind and seas. The main had been dropped immediately after the incident, but someone came up with the idea of hoisting the storm jib to give us some speed and also to counteract the cork-

Whenever *Serengeti* wandered toward the breeze, the backed headsail would drive the bow down. In this fashion, we slalomed our way toward Nassau. Because it gave us too much speed, the No. 4 jib, shown here, saw limited service.

screw effect the drogue had on the stern.

This proved to be a stroke of genius. Not only did this boost our boat speed to a solid 3 knots; the tiny sail also kept us more or less directly on course for Nassau. Every time the bow came into the breeze, the sheeted-home jib would back and send the boat into a controlled jibe. Once on the new board, the sail would fill, and the boat would accelerate until the bow again wandered toward the wind, whereupon the whole process would repeat itself. In this manner, pivoting around its nearly 14-foot keel and slaloming down a heading that wandered through about 30 degrees, *Serengeti* held an average course straight toward Nassau.

It was a good thing, too. In a call to BASRA, the all-volunteer Bahamas Air and Sea Rescue Association, we learned that even the cruise ships were weather-bound in Nassau. While the BASRA folks were sympathetic to our plight, they didn’t have the resources to lend assistance but asked to be kept apprised of our progress. And a commercial-towing outfit quoted a figure



of \$10,000 for a lift home. While it was clear we wouldn’t be able to sail right up to a dock, we’d be on our own until just outside Nassau. As Bill Tripp said in a sat-phone call to the authorities, “We’re getting there OK, but we’re going to need someone to catch us once we’re there.”

Sailmaker Mark Ploch reckoned, correctly, that with more speed, we’d have better control, so by mid-afternoon we’d swapped the storm jib for the No. 4 headsail. Instantly, we were making 6 knots. But the faster speeds proved too much for the drogue, which at 3 knots stayed submerged and provided the necessary drag to maintain course but skipped and planed atop the following waves at anything quicker. And once the drogue was clear of the drink, *Serengeti* instantly sprang up toward the breeze. (The position of the drogue was also critical to the overall exercise, particularly because

the waves were so close together. After a lot of trial and error, it became clear that the device worked best when streaming about 100 feet aft.) We tried trailing sheets and lines aft to induce more drag, but their effect was minimal. Reluctantly, down came the No. 4 and back up went the storm jib.

Late in the afternoon, off Nassau, we rendezvoused with a kind soul in a Mako-type runabout of about 22 feet powered by a 100-horsepower outboard. We used a stretchy anchor rode as a tow line, which in retrospect wasn’t ideal. Skipper Weiss was stationed by the throttle with the engine slowly turning over: “The anchor line was like a big rubber band,” he said later. “Without the jib up, it was very hard to keep the bow down, so when it swung in its maximum arc, I’d put some reverse on to compensate. We’d get a little pull, and it’d whip the boat from one direction to the other. A line with less stretch would’ve worked better. And it was probably



While not the ideal choice for such a powerful performance yacht as *Serengeti*, the Sea Claw drogue (right) enabled us to make Nassau. After further testing, designer Bill Tripp believes a webbed, conical drogue—like this one from Galerider (left)—would be the better option.



Rudder Loads on the Modern Cruiser

“Look! All I have is two fingers on the wheel! It doesn’t take anything at all to steer this boat!”

So why the big problem when the rudder falls off?

Let’s take a close look at how those two fingers turn the rudder. As an example, we’ll take a stock, 42-foot cruising sailboat from the pages of *Cruising World* and see what’s involved in steering it.

The fingers rest on the rim of a 30-inch-diameter wheel (see diagram, right). Turning the 30-inch wheel turns a 3-inch-diameter sprocket on which rides a chain connected to the steering cables. That’s a power ratio of 30:3 or 10:1, so 1 pound of force applied to the wheel rim delivers 10 pounds of force to the steering cable.

The rudder is a partially balanced spade—its stock is set back a short distance from the rudder’s leading edge. When the airfoil-shaped rudder is turned a small amount, its center of lift (the point at which the average of the forces on it act) is a little aft of the stock, in this case about 2 inches. The cable turns the rudderstock via a quadrant that has a radius of 16 inches, so the power ratio of the quadrant to this lever arm is 16:2 or 8:1. Combine this with the 10:1 power ratio of the wheel to the chain/cable, and the total power ratio is 80:1. Therefore, two fingers applying a force of 1 pound to the wheel rim deliver 80 pounds of force to the rudder (or counter a force of 80 pounds acting on the rudder).

And this is the easy case, with the sails well trimmed and the boat sailing to windward at about 5 knots in flat seas and 10 knots of breeze.

Let’s say that we have an emergency rudder deployed and that we want to generate the same steering force. We made the rudder by lashing a floorboard to the spinnaker pole, which is 14.5 feet long (see diagram below).

The boat has a regular “scoop” transom, at a 45-degree angle to the vertical, and our fulcrum for the “tiller” is by necessity at the deck. Because of the boat’s freeboard, to immerse our 3-foot-long floorboard, this fulcrum is 9 feet from the immersed end of the pole, putting the center of our rudder 7.5 feet

from the fulcrum. The in-board end of the “tiller” is thus 5.5 feet from the fulcrum.

The ratio of these levers gives us our power ratio, and it’s not in our favor: 5.5 on our end, 7.5 on the rudder’s end, or 1:1.36. Therefore, to generate our 80 pounds of steering force (or to counter a load of 80 pounds on the rudder), we need to apply a force of $80 \times 1.36 = 109$ pounds to the end of the tiller. That’s a lot of fingers. In reality, we’re going to have to work even harder than that because our floorboard is nowhere near as efficient a

“control surface” as our rudder was.

And we haven’t yet begun to take into account the boat’s motion in a seaway.

How Does a Drogue Steer?

Basically, all a drogue can give you is drag. By moving the towline to one quarter or the other, you can move the drag to one side and hope to steer the boat toward the side you’re

applying the drag. How much drag do you need? That depends on many things, but applying it effectively depends on your available lever arm.

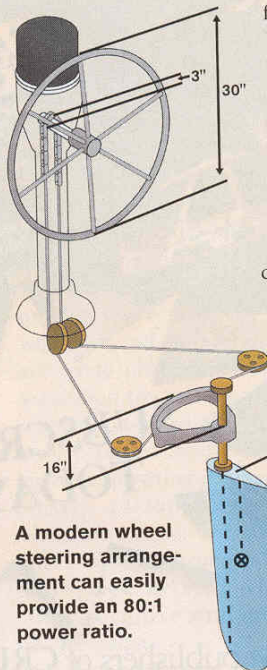
If we tow the drogue from a corner of the 10-foot-wide transom, that gives us a lever arm of 5 feet off the centerline. We can reduce that a little if we again drum our 14.5-foot spinnaker pole into service, center it across the transom, and tow our drogue from one end or the other. However, that entrains the practicalities of actually adjusting the drogue’s position to vary its effect (and whether or not the spinnaker pole was designed to support loads applied in this way). As *Serengeti’s* crew discovered, a drogue’s behavior even at slow speeds can be capricious, and they weren’t trying to steer with it.

Why Do Rudders Fail?

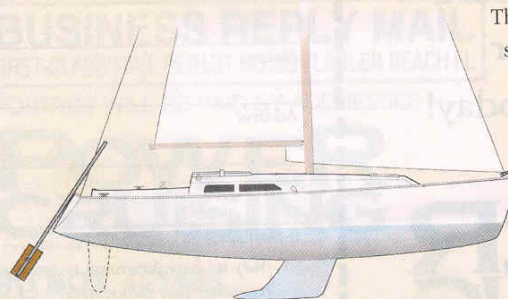
We’ve already seen that even in the easiest of steering situations, the rudder is subject to quite high loads. Because the load on the rudder is proportional to the square of the boat’s speed, it doesn’t take a radical change in conditions for that load to get markedly higher. An increase in boat speed from 5 to 7 knots doubles the dynamic pressure on the rudder, and at 10 knots it’s quadrupled. These loads are cyclical, and they sometimes create vibrations, both of which contribute to fatigue—inducing strains on the blade, the stock, and the bearings and the structure supporting them within the boat.

What would we expect the worst-case load to be on our rudder? Let’s examine a wipeout at 16 knots, with the rudder hard over and stalled out. Let’s assume maximum dynamic loading and the simplest case.

The dynamic load on a flat plate in a stream is expressed as $q = \frac{1}{2} \rho v^2 A$, where ρ is the density of the fluid, in this case seawater at 64 pounds/cubic foot; v is the velocity in feet per second, so multiply by 1.69 for speed in knots; A is the area of the plate; and g is gravity, conventionally 32 ft./sec.². This all boils down to $q = v^2 A$.



A modern wheel steering arrangement can easily provide an 80:1 power ratio.



The textbook “board-and-spinnaker pole” emergency rudder is a very poor substitute for the real thing.

Our rudder only goes to 35 degrees, so the frontal area it presents is $A(\sin 35)$ or .57A.

At 16 knots, with our 9-square-foot rudder, $q = (16 \times 1.69)^2 \times 9 \times .57 = 3,751$ pounds. The rudderstock has to be able to support the equivalent weight of a J/24 and its four crew.

The helmsman would feel $3,751/80 = 46.9$ pounds on his fingers. Sound about right?

Spade or Skeg?

It's an old debate. There's no question that in terms of lift versus drag, the spade rudder is the most efficient type of control surface used in steering a sailboat. And although experimenters have played for decades with rudders mounted forward, it's no accident that rudders today are mounted about as far aft as it's physically possible to put them. It didn't take primitive man long to figure out that his arrows flew straighter with a couple of feathers stuck on their back ends. But when a spade rudder falls off a boat, we effectively are left with an arrow with no flights. As we've learned from those who've tried to do it (see "An Oar to Steer Her By," March 2003), balancing the ever-changing forces acting on sails and a fin keel in the absence of a rudder is nigh impossible. Many rudderless boats have been abandoned.

Would a skeg improve the odds of being able to steer the boat? If it wasn't damaged by whatever caused the rudder to fail, I think its surface area located well aft would contribute somewhat to directional stability. I believe yacht designers could devote some effort to studying this possibility. Forget efficiency for a moment and examine contingency. *Serengeti* is designed to race, and when doing so, she has a large crew of strong sailors to handle her. The spade rudder serves her best. Mr. and Mrs. Retiree aboard their contemporary production performance cruiser don't have quite as many options should they find themselves in extremis. Maybe boat designers should give them some.

Jeremy McGear

way too long. We kept making it shorter and shorter to reduce the bouncing action—the shorter, the better.”

It was slightly hairy negotiating the harbor entrance, but by sundown, we were alongside a dock and thinking about refreshments. *Serengeti*, sans rudder, was ready for the next chapter. The torn, trashed drogue didn't fare as well, though it would've been a struggle to reach Nasau without it.

Designer's Postmortem

When it was all over, I asked Bill Tripp what he'd learned. His answers were insightful. "I'd never needed a drogue before and now realize how important they can be," he said.

"The drogue we had wouldn't stay submerged when we were going fast enough. That was a real problem, a double-edged sword. Because you need the sails to steer, and the sails make you go fast, we had to put on as little sail as possible and not have the boat go more than 4 knots. Our drogue popped out of the water at 3.5 knots. We needed one that worked at 6 knots. When you have a following sea, speed is better than no speed. The less speed you have, the more the waves are throwing the boat around."

In the aftermath, one of the designers in Tripp's office tested a number of drogues on The Solent, in England. In the future, Tripp plans on specifying drogues for his new designs and will also incorporate fold-down padeyes aft so there's a ready place from which to deploy them. "We needed a drogue that wasn't so dependent on being full, which isn't a bagful of water," he said. "The kind you want looks like a huge net—it has a big circle and huge webbing and looks like a cone. It doesn't have an open/close aspect to it like the one we had. And we didn't know that. In smooth water, I think the Sea Claw would work well. But it had that aspect where, if you changed half a wavelength on it, suddenly it would surf, and when it surfed, it collapsed. And once you were going 4 knots with it collapsed, it wouldn't fill again."

All in all, Tripp described the incident as an eye-opening experience. "In the design process, you can't imitate a boat without a rudder. It isn't possible," he said. "I've done all the Newport-Bermuda Race tests where you have to prove you have emergency steering, and you do that by lashing the wheel and then dragging a spinnaker pole back and forth [off the

transom]. And you can do that in flat water; it works fine. Out at sea, it doesn't, particularly if you have to go dead downwind. If you want to set the boat up on a reach or even go upwind, you can do both by trimming the sails, but downwind is the hard one. Because the waves just take the stern and pick your course."

Tripp, however, was confident that had we been outside Eleuthera in the open Atlantic when the rudder vanished, a high-performance boat like *Serengeti* would've fared well. "I think with a double-reefed main, we could've climbed up on the breeze," he said. "We would've sailed the boat by trimming and dumping the mainsail, the old dinghy thing. The disadvantage of a boat like this is that when it breaks its rudder, it's like a dinghy. On the other hand, the advantage is you can sail it like a dinghy.

"Anyway," he concluded, "it was certainly an adventure. I wish it hadn't happened, but since it did, I was glad I was there."

Epilogue

It turned out that it wasn't a case of whether *Serengeti's* rudder would fail or not—it was inevitable—but when it would happen. When the boat was loaded onto a barge to begin its journey from New Zealand to the States two years ago, its rudder clipped the deck due to a problem with uneven hoisting straps. For a variety of reasons, it wasn't inspected at the time. But the shattered remnants of the carbon post revealed what Weiss called "a catastrophic failure." There was evidence that the stock had been wearing away ever since the boat was launched.

Even so, within a few weeks *Serengeti* was fitted with a new appendage and sailed on to Antigua, where in late April she competed in Sailing Week. But in mid-May, the boat suffered major damage to her hull and rig after being struck by a cruise ship while anchored in St. George's Harbour, Bermuda.

As for the Pineapple Cup, the strong northerlies held on, and nine of the 16 competing yachts beat the old race record of 2 days, 23 hours, with the victorious 75-foot *Titan 12* taking over 12 hours off the mark in posting a new record of 2 days, 10 hours, and change. By all accounts, it was a helluva ride.

Then again, so was ours.

Herb McCormick is *CW's* editor.

<http://www.santanasailing.com/blog?category=Basic+Cruising+2>