WindCheck
Sailing the Northeast

What? How Small a Wave Can Capsize My Boat?!

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We've covered many seamanship topics here over the past several years. Topics such as what the COLREGs mean (see WindCheck from June 2010 through November 2011), how to handle heavy seas (WindCheck, "Skippering in Heavy Weather" January 2012) and what to do if the boat's afire (WindCheck, "Boat's Afire!" March 2012) have been among the literally hundreds of topics we've covered (archived at windcheckmagazine. com>monthly>Captain of the Port). One thing we haven't covered is the general topic of capsizing. There is a tremendous amount of data on "righting moments," centers of buoyancy and gravity, thanks to the US Navy and the US Coast Guard and many other institutions who literally live and die by these metrics. We've also seen a couple of columns here about wind and waves, which are the agents of capsizing (see Wind, "Wave Theory and Practice" October 2010, "Wave Theory and Practice, Part II," November 2012 and "Waves Upon, and Within, Waves" December 2012.) But there has been very little direct data on what that translates into in terms of your 25-foot boat and 8-foot seas at the Inlet. This column is about that.

Some Background

To understand the forces of a capsizing, and how those forces changes when you load the boat, let's get some terms under our belt. Most of us understand "center of gravity" (G) instinctually. But what is the center of buoyancy? The center of buoyancy (B) is the center of the volume of water which the hull displaces. When a ship is stable, the center of buoyancy is vertically in-line with the center of gravity of the ship. So, as long as the center of gravity (G), pushing the boat down, is above the center of buoyancy (B), pushing the boat up, we're good. How good? That is a very good question and as with many good questions, it requires more information to answer properly.

What is that "M" sitting up there above our trusty center of "G"ravity and the center of "B"uoyancy? That is something very important called the "M"etacenter. The metacenter remains directly above the center of buoyancy regardless of the heeling (tilting caused by external factors like wind or waves) or listing (tilting caused by internal factors such as poorly stowed cargo or on-boarding of water by wind or waves) of a boat. If you are starting to worry about the distance between "G" and "M", called the "Metacentric height" (or "GM" in naval architecture parlance), you're catching on quickly. The math gets pretty complicated from here, but suffice it to say that the ability of the boat to right herself (i.e. her "righting arm" or "righting moment") has a lot to do with GM. The larger the GM acting as a lever, the better.

Sailboats are designed to operate with a higher degree of heel (greater GM) than motorboats, but the principles are exactly the same.

From This to Wave Height?

Yes. You can infer that your motorboat's center of gravity and center of buoyancy can't be too far apart

when the entire distance from the keel to the floor boards is probably something like two or three feet. Think of her draft. It isn't a big number, even for a 40-footer. No reason to panic, but you now realize that M, G and B can't be that far apart – which means that GM just can't be that great either. And GM is a surrogate for the righting ability of your boat.

But wait. I've been out in some pretty steep seas and I think the boat handled it well. Yes, because studies conducted by the Society of Naval Architects and Marine Engineers (SNAME) determined that three things must exist for a capsizing to occur:

1. The boat is broadside to the wave. Yes, a boat can be pitchpoled (tossed end-over-end), but the size of the wave needed to do that greatly exceeds the size of the smaller wave needed to knock a boat down when broadside to a wave.

2. The boat is struck by a breaking wave.

3. Wave height must exceed a certain percentage of the boat's length. At this point, the wave contains enough energy to overcome a boat's righting moment.

So, what is that "certain percentage?" At only 30% of your boat's length (about six feet from trough to crest for a 20-foot boat), things enter directly into the realm of high danger. At 60%, it is nearly certain that one wave will catch you and then you, the crew and the boat may well come to grief.

So, before trying to transit these coves and bars that control much of our access to the open sea, think about just how much of a righting arm your boat can possibly have…

BTW, if you are interested in being part of USCG Forces, email me at JoinUSCGAux@aol.com or go direct to the D1SR Human Resources department, who are in charge of new members matters, at DSO-HR and we will help you "get in this thing…"

Captain Joe Vojvodich is the Captain of the Port and Sector Commander for US Coast Guard Sector Long Island Sound. Captain Vojvodich is responsible for all active-duty, reservist and auxiliary Coast Guard personnel within the Sector. Vin Pica, Chief of Staff for the First District Southern Region in the US Coast Guard Auxiliary, works closely with Captain Vojvodich and his staff to promote boating safety in the waters between Connecticut, Long Island and 200 nautical miles offshore. Sector Long Island Sound Command Center can be reached 24 hours a day at 203-468-4401.