

Mast Selection .. excerpt from Bob Sterne's "How to Sail Fast"

The first thing that you need to do to tune your boat, now that you have selected your rig, is to determine the proper mast position. This is also the last thing you should do, after you have the boat all trimmed out. In other words, tuning is a circle. When you are all finished, you should go back to the beginning and check everything again. Remember, one change may require as many as half dozen others. Now, what is the proper mast position? It's probably different for every rig, and for every 10 degrees of heel. To understand this, you must go back to the basics of trim for sailing to windward. Traditionally, a boat should carry a slight weather helm when sailing close hauled. This enables it to point as high as possible, and to "hunt" out its own lifts when they occur. By slight, I mean that it should not require you to constantly hold the helm down, but the boat should sail several boat lengths without luffing in steady winds, gradually coming to the point where the windward jib telltales will flutter, and will require you to bear off very slightly. This is optimum helm for sailing to windward. It gives the boat "life" and "feel" and forces you to become part of the boat, making these corrections exactly when (or even before) they are needed. If the boat has too much weather helm, you will feel as though you are fighting it. In fact, that's exactly what you're doing. If it sails as though it is on rails, then it may have either neutral helm, or a slight amount of lee helm. In this condition the boat may not point well, particularly in light airs. If the boat has severe lee helm, it cannot be made to point, and in light weather you're going to get killed. If you've noticed the relationship between pointing ability and weather helm, congratulations. You have just answered your questions from those days when you said "my boat won't point."

Weather helm is caused by two opposing sets of forces acting about the Centre of Lateral Resistance (CLR) of the boat. There is a set called the "lee couple" and a set called the "weather couple," depending on which way they want to make the boat turn. If the "lee couple" is less than the "weather couple," you have weather helm. The lee couple consists of : side force x "lead." The weather couple consists of : driving force x "shift", plus pressure on the lee bow. The "lead" is the distance that the Centre of Effort (CE) of the sails is ahead of (leads) the CLR, measured along the centreline of the boat. The "shift" is the distance that the CE is displaced sideways (shifted) from the centreline, which in turn is the height of the CE times the Sin of the angle of heel. If the "lee" and "weather" couples are not equal, the difference must be made up by the rudder. The amounts of side force and driving force are related to wind speed, sail shape, and sail area, but for fixed conditions we can ignore their variations. The pressure on the lee bow is related to boat speed, shape, and leeway, but again we will ignore it. The things we have easy control over, and that make the largest difference are the "shift" and the "lead." The "shift" can be changed in two ways. We can fit a different height of rig, which works by changing both the height of the CE, and also the angle of heel. Taller rigs will increase weather helm, and vice versa. Alternatively, we can alter the trim of the sails to change the angle of heel, with more heel giving more weather helm. This is the basic reason that a boat rounds up to weather when you sheet in, which can be used to great advantage in rounding mark, or in doing penalty turns. It will also kill you if you try to bear off when the boat is heeled very far without sheeting out.

The “lead” can also be changed in two ways. If we bear off without sheeting out, the CE moves aft slightly, and the “lead” will decrease, increasing weather helm. This is why a boat can be tuned to sail like is “on rails”. If it heads up, the CE moves forward, causing lee helm, and the boat to bear off. If it bears off, the CE moves aft, causing weather helm., and the boat to head back up. The boat is in perfect tune (helm-wise) for that course. The problem is that course is not necessarily as high as the boat can point, and is more likely to be a few degrees lower. Boats that are “on rails” can be a joy to sail, but be careful, because they tend not to point quite as high. The other method of changing the “lead” is to move the mast. Moving the mast aft decreases the “lead” and increases weather helm. Likewise, forward is lee. Mast rake has the same effect. We now have a method of altering our boats’ weather helm to suit our requirements.

I have a basic rule that I try and remember when I am having problems with helm and/or pointing ability. THE AMOUNT OF HELM IS DEPENDENT ON THE POSITION AND SHAPE OF THE LEACH OF THE MAINSAIL. If it is too far forward, the boat won’t point. Too far aft, and there is too much weather helm. If it has a lot of twist, the angle of heel will be less, the CE will move ahead, and the mast may have to be moved back to compensate. If it is strapped down hard, the boat will heel like mad, and the CE will move aft, causing the boat to head up. The mast may have to move forward to restore balance. When you are sailing the boat at its optimum 30 to 35 degrees of heel, experiment with various mast positions until you find the optimum. Remember, for determining this position, the sails should be trimmed for maximum efficiency and drive. As a starting point, this means that the center third of the mainsail leach should be parallel to the centreline of the boat, and when viewed from behind, the jib leach should parallel the main leach, far enough out to prevent back winding. This will give you a centre point for your mast step, and you should have about an inch of adjustment left in either direction. This will allow for a variety of wind conditions and sail trims. The amount of “slight” weather helm that your are after should virtually disappear when you move the mast ahead about $\frac{1}{2}$ inch, and the boat should point nearly as high and feel like it is “on rails”, providing the angle of heel stays between 30 to 35 degrees. I find that each additional 10 degrees of heel will require the mast to move ahead about $\frac{1}{2}$ inch to maintain the same helm and vice versa. But you should confirm this for your boat. Don’t forget to re-check for every rig you have. If you can’t remember them, write them down in a notebook. This is an excellent idea in any case, and not only for the mast position, but for everything else about tuning the boat as well.