



## Balance Your Helm for Speed

*John Ellsworth shows how to balance sails and hull for better sailing.*

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**A boat sailing to windward** in a strong breeze may feel as if it is traveling on rails, being pushed or pulled straight ahead by a single driving force, but this is not the case. Let go of the tiller or wheel, and boat begins turning, most often into the wind.

When you release pressure on the rudder, you upset a balance of forces that combine to move the boat forward through the water. Achieving a proper balance of these forces makes a boat faster, easier to sail, and more responsive. But what are the forces involved? What is their proper balance, and how do you achieve it?

### Effort and resistance

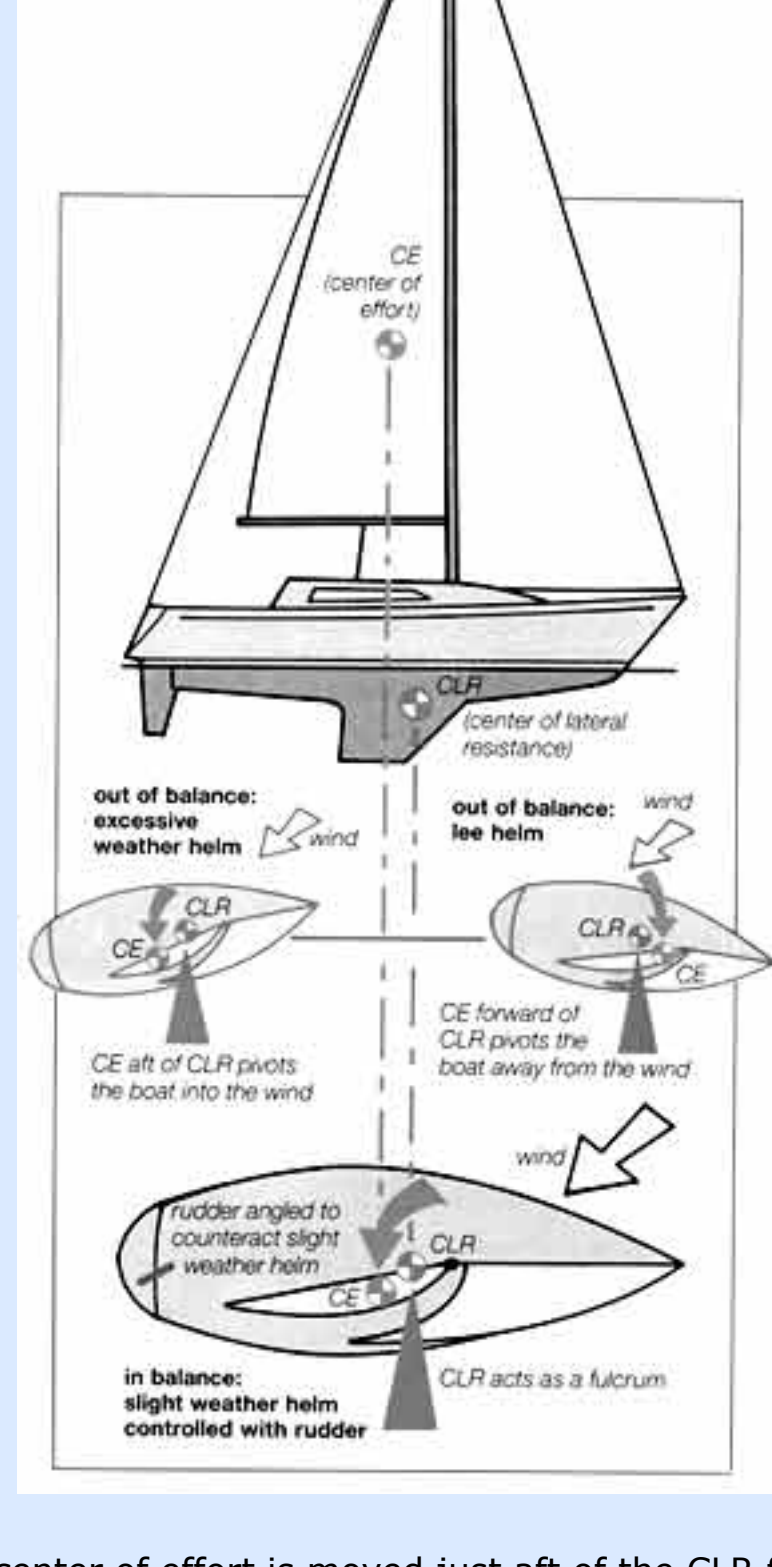
In order for a boat to sail a straight course, two opposing forces directed across its movement must be brought into balance. These two primary forces are centered in the sails and the hull.

**The center of the force**, or lift, generated as wind flows over the sails is called the *center of effort* (CE). The pressure of the water against the rudder, keel or centerboard, and hull resists this pull and balances against it, working with the sails' force to move the boat ahead. The resistance of the hull is focused at the *center of lateral resistance* (CLR).

The relative positions of the two forces determine whether a boat wants to turn into the wind, away from the wind, or sail a straight course when the helm is released.

### Balance

To understand how sail power and hull resistance balance one another, imagine that the boat's center of lateral resistance rests on the fulcrum of a scale (Fig. 1). When the center of effort is in line with the center of lateral resistance (neither forward nor aft), the boat balances evenly on the fulcrum and sails a straight course with the rudder on centerline.



**Figure 1:** The position of the center of effort (CE) relative to the center of lateral resistance (CLR) determines the boat's balance. The CLR acts like the fulcrum of a scale.

If the sails' center of effort is moved just aft of the CLR fulcrum, the stern is pushed away from the wind and the bow turns into the wind. This imbalance, with the scale tipping toward the stern, is called weather helm. Moving the sails' center of effort forward of the center of lateral resistance tips the scale in the other direction and forces the bow away from the wind, creating lee helm.

Balance is transmitted to you directly by the rudder—you can feel the turning pressure. Either a slight weather or lee helm can be effectively controlled and a straight course maintained by holding the rudder at a small angle with pressure on the tiller or wheel. When the center of effort is directly above the center of lateral resistance, the helm feels very light, or neutral. If you release the helm when it is in neutral, the boat sails a straight course.

### Ideal balance

The most desirable balance to windward is a very slight weather helm. To steer a straight course with weather helm, pull the tiller to windward or turn the wheel to leeward. Set at an angle of 2 to 4 degrees to correct slight weather helm, the rudder actually works with the keel to generate lift like a sail or wing as the boat moves through the water—the boat can actually sail faster and point closer to the wind.

Weather helm also provides an important safety mechanism: If you release the helm, the boat automatically turns into the wind, spills pressure from the wind in the sails, slows down, and then stands upright.

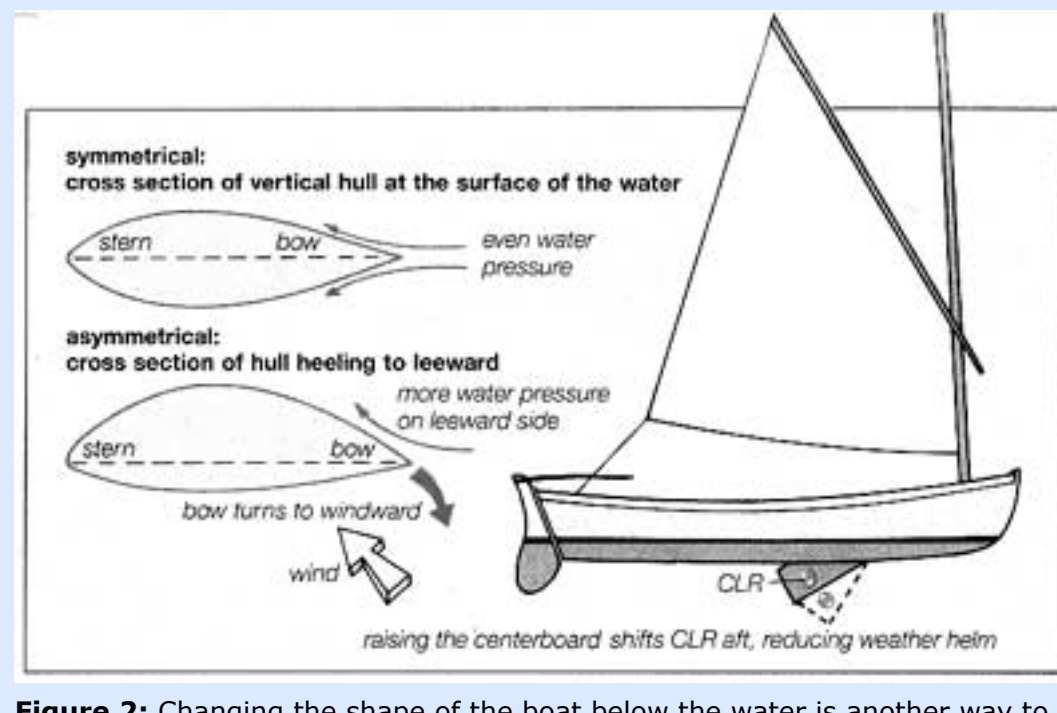
**In addition, a slight weather helm** increases steering feel and responsiveness. The light pressure from the rudder gives you direct feedback, or feel for the boat's movement and balance. The tendency to point into the wind when the helm is eased makes for lively and responsive steering.

### Changing balance

Balance is dynamic. It shifts with wind strength and angle, sail trim and shape, angle of heel, and position of weight. You can adjust many of these variables to fine-tune the helm and improve the overall performance of your boat.

You can raise or lower the centerboard if you have one, change sail trim and shape, move crew weight, and shift the position of your sails by moving the mast. These strategies fall into two major categories: (1) moving the center of effort fore and aft and (2) moving the center of lateral resistance fore and aft.

**Centerboard.** If your boat has a centerboard, you can use it in combination with sail trim and weight placement to adjust balance. When you raise the centerboard, the boat's center of lateral resistance moves aft, reducing weather helm (Fig. 2).



**Figure 2:** Changing the shape of the boat below the water is another way to adjust balance. Heeling the boat to leeward creates a hull shape that turns the bow into the wind, increasing weather helm. Shifting crew weight to reduce heel will also reduce weather helm by making the underwater surface more symmetrical. On centerboard boats, you can lower and raise the board to move the center of lateral resistance (CLR). To reduce weather helm, raise the centerboard to move the center of lateral resistance aft.

**Shift weight.** You can move crew weight to adjust balance. An upright boat presents a neutral, symmetrical shape to the water, but as a boat heels, the hull shape loses its symmetry and forces the boat to turn (Fig. 2). The larger curve on the leeward side pushes the bow to windward, increasing weather helm. The greater the heel, the greater the push to windward.

In addition, the sails and center of effort move outboard as the boat heels. This gives the center of effort more power over the center of lateral resistance and adds weather helm. As the wind builds and weather helm increases, move crew weight to the windward rail to reduce heel and weather helm.

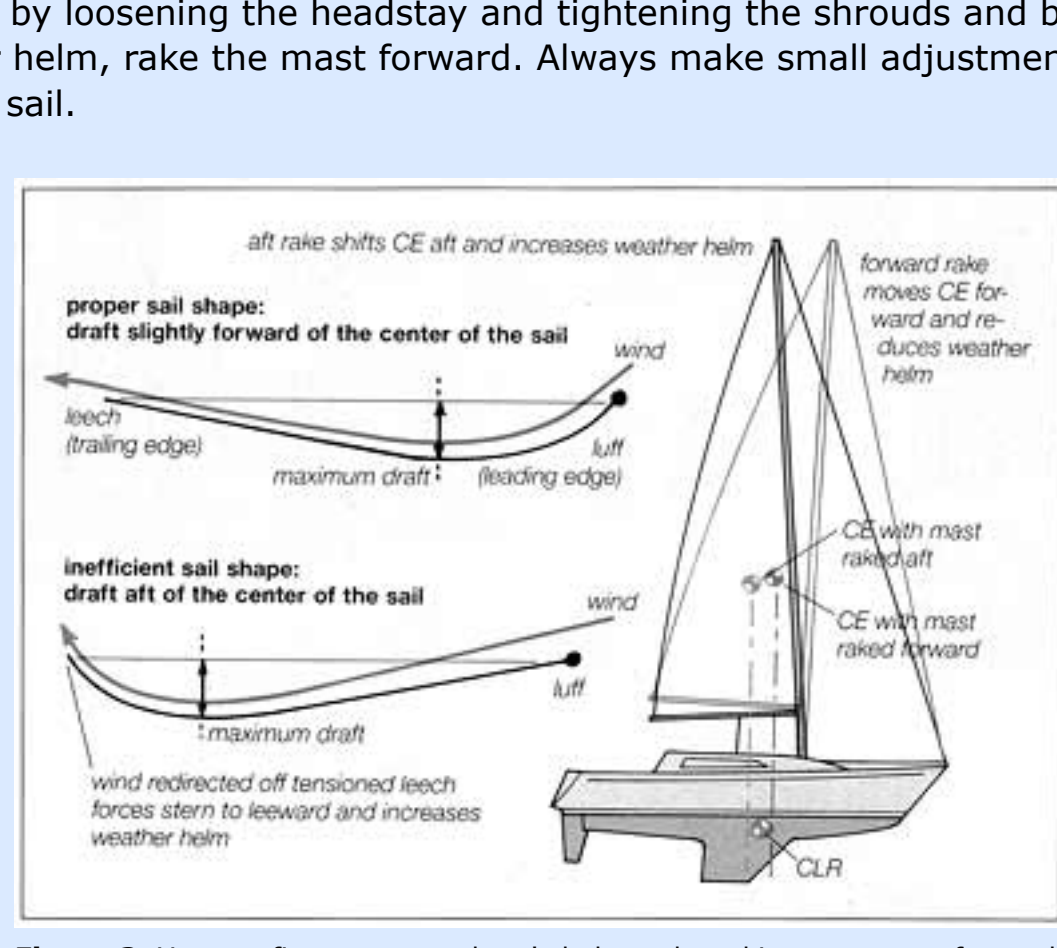
Conversely, if you experience lee helm in light air, shift crew weight to leeward to heel the boat and build weather helm. Remember, make small changes in weight placement and check the effect on your helm each time.

**Sail trim.** The trim and shape of your sails determine the position of the boat's center of effort. When you feel excessive weather helm through the rudder, the sails' center of effort is too far behind the center of lateral resistance. Moving the center of effort forward reduces weather helm. To do this, either decrease the power of the main or increase that of the headsail. You can ease the mainsheet and boomvang, flatten the sail by tightening outhaul and cunningham, or trim the jib. In high winds, reduce mainsail area with a reef.

You correct lee helm with the opposite strategy: Move the center of effort aft. Trim the mainsheet and boomvang and ease the outhaul and cunningham to increase the main's power. Ease the jib to reduce sail power forward.

If you have a lot of weather helm sailing to windward, check the shape of your mainsail. The draft of a sail tends to move aft in heavy wind. This hooks the trailing edge, or leech, of the sail to windward, increasing weather helm (Fig. 3). To correct this problem, pull the draft forward by tightening the cunningham and flatten the sail by tightening the outhaul. You can also ease the mainsheet and boomvang.

**Change the mast rake.** You can also change the angle, or rake, of the mast, moving the total sail area, or sail plan, forward or aft (Fig. 3). Raking the mast toward the stern moves the center of effort aft relative to the center of lateral resistance and reduces lee helm. Do this by loosening the headstay and tightening the shrouds and backstay if you have weather helm, rake the mast forward. Always make small adjustments and test the results under sail.



**Figure 3:** You can fine-tune your boat's balance by raking your mast forward and aft. Angling the mast aft will move the center of effort aft and increase weather helm. If the wind comes up and weather helm increases, check the shape of the mainsail. Wind deflected off a tight leech will slow the boat and add to weather helm.

### Listen to your helm

As you work to achieve balance, remember your rudder is the best gauge of the boat's performance. Feel the pressure against the tiller, make small, individual adjustments, and monitor their effects. Eventually you'll become more familiar with the characteristics of your boat, and you'll be able to achieve balance and optimum performance quickly and confidently when sailing to windward.

**Checklist: Strategies**

**To reduce weather helm:**

**Move CE forward**

- Ease mainsheet and boomvang
- Flatten main by tensioning outhaul and cunningham
- Trim headsail sheet
- Reef main (in high winds)
- Rake mast forward

**Move CLR aft**

- Shift crew weight aft
- If heeling, move crew weight to windward
- Raise centerboard

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**To correct lee helm:**

**Move CE aft**

- Trim mainsheet and boomvang
- Add power to the main by easing outhaul and cunningham
- Ease headsail sheet
- Rake mast aft

**Move CLR forward**

- Shift crew weight forward
- If boat is not heeling, shift crew weight to leeward
- Lower centerboard