

# Raising centerboards and CoE and CLR ramifications

**CoE = Center or Effort CLR = Center of Lateral Resistance**

Determining if you should raise centerboards on a skiff is always a question. Let's look at the Center of Effort and Center of Lateral Resistance. Using a Hobie 16 with no centerboards, its hull develops sideways resistance due to their shape and their depth/blade like nature in the water.

A skiff's hull tends to be very shallow and therefore when sailed properly and flat, develops very little sideways resistance (the hull), (CLR) is left up to the foils to do all that work and they do it far more effectively than a Hobie hull.

For reasons of balance/feel, you carry approx 10% of the side load on the rudder, 90% is carried on the centerboard.

On 29er foils it is very easy to work out where the CLR is; it's a simple rectangle so it's similar to the jib, find the CoA, and then go fwd to approximate the 40% point. (a 29er foil section is particularly efficient so it carries the CLR approx 40% back from the LE (leading Edge)).

If you lift the Centerboard you lift the CLR approx 1/2 the amount, So if you lift the Centerboard 150mm you will roughly lift the CLR 75mm.

The 29er Centerboard is approximately 150mm longer than it needed to be (so one person could easily right the boat) but again the section is particularly "clean" so the penalty for leaving it down is not that great!

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There is a very direct relationship between CLR and CoE, the force that one generates is directly and absolutely resolved by the other.

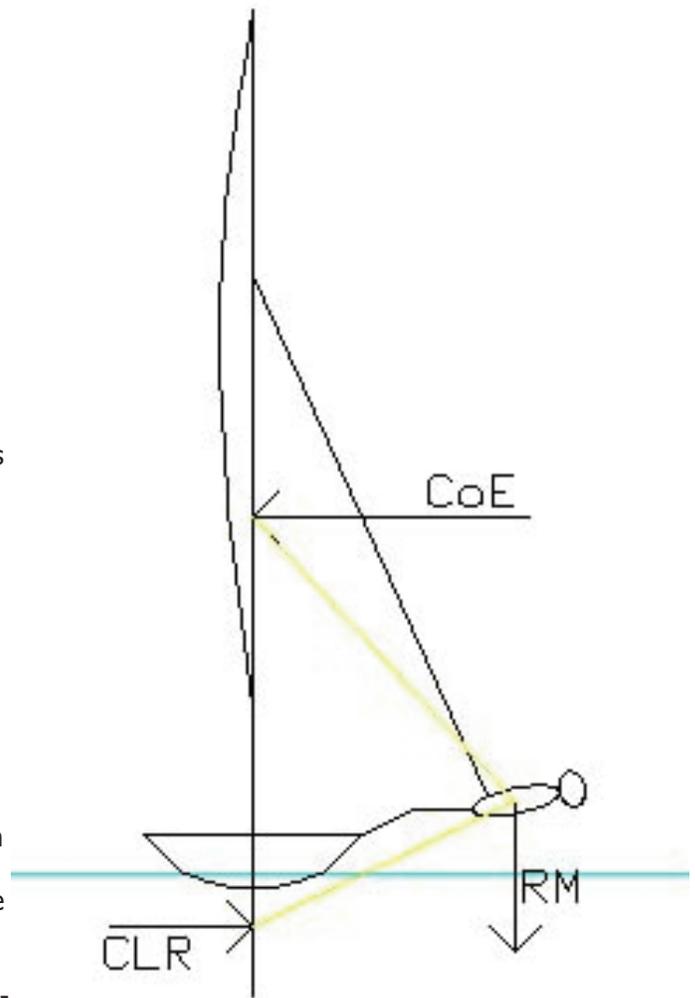
So if you lift your centerboard it may well feel like you are lowering your CoE. In fact it does not, they are independent in terms of their placement but the linkage which is often known as the Arm will get shorter, so it may feel like you are lowering it. That shortening will make your hiking more effective.

Attached is a map. On it you will find CLR and CoE, they by definition have to equal each other!!!! The whole thing is kept in balance by RM (Righting Moment) which is you and the crew hiking, the sum of you hiking and his trapezing. Too much RM and you roll to windward and you have to bend your knees, to little and you heel and you have to ease to main or capsize.

So if you lift the board, you do about 3 things, most important is you lift the CLR and you make the arm, the distance between CoE and CLR reduce. This reduces the base of the lever or what is better known as the power triangle which is the triangle from the CoE to CLR (Arm) to RM which therefore makes the RM more effective, therefore you can generate more power, therefore go faster. It's basic trigonometry.

The other things it does is reduce wetted surface area of the foil, and as foil drag equals approx 15% of total system drag, it's a fair bit, also by increasing effective power you load up the main more and that in turn blades the leach off more lowering the CoE, so a small reduction in CLR can lead to a disproportionate reduction in Arm by lowering CoE as well as raising CLR.

If you pull it to fair up, the boat will start slipping sideways, and increase the "induced" drag of the foil (Centreboard).



The old skiffy terms where "trippy" if it's too far down and "Slippy" if it's too far up. The benefit of a 29er foil is it has a very lower drag signature so you will need to get pretty close; there will be definitely an advantage from Arm reduction, but you need to get out there with marks on the trailing edge of the foils so you know you have it 150 or 160mm up, on the 18er it was +/- 10mm and you could feel the difference in both performance and feel. On a 29er it will depend on who is steering; someone prone to pinching will need it down some more, someone who foots a lot, should have it up more.

My preference: board up approximately 150mm once you are hiking hard, rarely bending the knees in the lulls, and up 200-250mm when its fresh, 18-20 knots. When its 25+ you want to be right up under the bottom of the sail.

The ability of the board to resist side load goes up as the square of the speed, so in 10-12 knots of wind you will be doing 7 knots of hull speed,  $7 \text{ sq} = 49$ . In 18 knots of wind speed, hull speed will be up around 10 knots so  $10 \text{ sq} = 100$ . Theoretically you should be able to get away with 1/2 the foil.

It does not fully work like that--there are other mitigating issues which make it more complicated like it having a low drag so the gain is not worth the pain (tippy into windward).

Its a question of feel, but you need to find that point.