The Sailboat Market
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THE NUMBERS GAME

You can learn a lot about a boat from its published ratios When buying a boat, consider how its ratios compare with those of similar boats in its category.

DISPLACEMENT-LENGTH RATIO

The displacement-length ratio (DLR) is a nondimensional expression of how heavy a boat is in relation to its waterline length. A DLR is calculated by dividing a boat's displacement in long tons (2,240 pounds) by one one-hundredth of the waterline length (in feet) cubed. Since the displacement in long tons can be expressed as a volume (in cubic feet of seawater), and since length-cubed is also volumetric, the DLR formula is nondimensional--the units of the numerator and the denominator are the same, feet cubed.

Displacement-Length Ratio = (displacement/2,240) / (.01xLWL)^3

The advantage of this is that the DLR can be used to compare the relative heaviness of various boats no matter what their size. For example, a boat with a 25-foot waterline and one with a 50-foot waterline are equally heavy relative to their respective waterline lengths if they have the same DLR. The relative heaviness of boats is often categorized as follows:

DISPLACEMENT	DLR
Ultralight	under 90
Light	90 to 180
Moderate	180 to 270
Heavy	270 to 360
Ultraheavy	360 and up

Note that the above gradations are applicable to current designs, which tend toward reduced overhangs and longer waterlines than earlier boats. For example, most sailboat designs of the 1930s through the 1960s had DLRs above 300, but with their long overhangs their sailing length was increased as they heeled, resulting in "effective" DLRs at speed that were well below their calculated values.

The significance of the displacement-length ratio is that the lighter a boat is relative to its waterline length, the higher is its speed potential. If there is less water to push aside, wavemaking drag (which predominates at high speeds) is reduced. Some ultralight-displacement boats, or ULDBs, are light enough to plane just like a powerboat. While at first it might seem desirable to have a low DLR, as in most aspects of yacht design there are trade-offs. In general, the lower the DLR, the less comfortable the boat's motion is in a seaway and the more sensitive the boat is to overloading.

SAIL AREA-DISPLACEMENT RATIO

The sail area-displacement ratio (SADR) is the nondimensional expression of the relationship between a boat's sail area and its displacement. It is calculated by dividing the nominal sail area in square feet by the boat's displacement in cubic feet to the two-thirds power.

Sail Area-Displacement Ratio = sail area / $(\text{displacement}/64)^{2/3}$

The displacement is converted from pounds to cubic feet by dividing displacement by 64, the weight of a cubic foot of seawater. The standard displacement used by most yacht designers for comparative purposes is the half-load displacement, calculated with the boat equipped for sailing with the crew and half the consumables (provisions, water, fuel, supplies) on board.

The nominal sail area is calculated as the sum of the foretriangle area (one-half the base, or J dimension, multiplied by the height, or I dimension) and the mainsail area (one-half the foot, or E dimension, multiplied by the hoist, or P dimension).

The SADR is termed nondimensional because sail area in square feet is divided by a displacement term that has been converted from cubic to square feet. This mathematical manipulation results in a parameter that again is independent of boat size. Therefore, a 30-footer with a SADR of 20 will have just as powerful a rig as a 60-footer with the same SADR.

Sail Area-Wetted Surface Ratio = sail area / wetted surface

In general terms, a boat having a sail area-displacement ratio under 15 would be considered undercanvased; values above 15 would indicate reasonably good performance; and anything above 18 to 20 suggests relatively high performance, provided the boat has sufficient stability and a low enough displacement-length ratio to take advantage of its abundant sail area.

The SADR is analogous to an automobile's horsepower-to-weight ratio, with sail area being a measure of power and displacement being indicative of wavemaking drag. The principal components of drag are friction and wavemaking; since wavemaking increases disproportionally with speed, the SADR is indicative of performance in moderate- to heavy-air conditions.

In light air most of the drag is due to friction--thus a boat's sail area-wetted surface ratio is the appropriate performance parameter. Unfortunately, wetted surface area is rarely included in a boat's published specifications.

It is important when comparing the SADR for different boats to be certain that the sail area and displacement values are measured in the same way for each boat.

A boatbuilder may publish sail areas and displacements that are larger and lower, respectively, than nominal so as to maximize a boat's SADR. This is done by quoting the area of an overlapping genoa, or, with a cutter rig, including the area of a staysail instead of foretriangle area, or, in the case of displacement, publishing the light-ship weight of the boat as shipped from the builder (without including supplies or fuel) rather than the half-load displacement.