THE ULTIMATE PROPELLER TEST

Which is the best prop for your boat? In the most comprehensive test ever published, Emrhys Barrell and the YM team compare 15 propellers for speed, thrust, drag, stopping distance, prop walk and price

What's the difference between a bucket and a fixed, three-bladed propeller? Not much, if you want to slow your boat down by at least half a knot when you are sailing. That's the conclusion of our test on fixed, folding and feathering props – the most detailed ever conducted in the UK, and as far as we are aware, in the world. A fixed three-bladed prop, free to spin, exerts as much drag as hanging a bucket over the stern of our test boat. And if you lock the shaft, as many gearbox manufacturers require, then you might as well chuck another bucket over the stern and lose a whole knot of boatspeed. Put another way, prop drag will add about four hours to a typical cross-Channel passage.

So what is the solution if you don't want to sacrifice precious speed? The answer is, fit one of the many folding or feathering propellers on the market. But which one, and what are the drawbacks?

We tested all the props we could get our hands on, measuring top speed under power, thrust (bollard pull) ahead and astern, stopping distance, and – for the first time in a sailing magazine – we measured the side-force (prop walk) generated when you put the engine into reverse. It is this vital, unwanted component that sends you swinging off to one side when you try to stop suddenly, or back-up in a marina. We then towed three typical props behind a test boat to measure their drag, and how it contributes to the overall drag of a yacht under sail.

Prop drag has been an issue for sailing vessels since the propeller was invented. Early trials were carried out on English warships, using jointed shafts that could be lifted into a trunk in the hull when sailing. In the 1890s, Danish pilot boats used similar lifting shafts.

For many years, long keels reduced the drag of two-bladed props on yachts, but the advent of the fin keel and exposed shafts brought the problem back again, with the added factor of more powerful engines making three-bladed props a necessity. The need to manoeuvre precisely in tightly packed marinas and overcrowded harbours has convinced even the owners of many long-keeled yachts to fit three-bladed props.

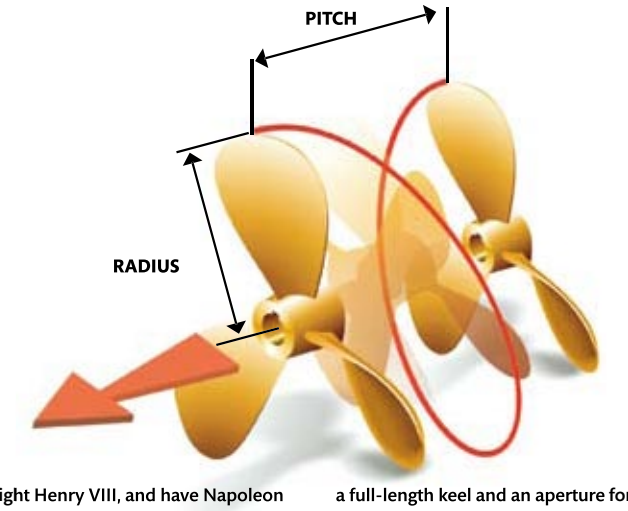
Most cruising skippers simply ignored the unwanted drag and loss of speed, but in racing circles it became increasingly significant. This led to the development in the 1960s and '70s of propellers whose blades folded backwards when sailing, reducing the drag markedly. The blades flew out under centrifugal force when the engine was put into ahead or astern. The earliest folding props had blades that moved independently, but this could lead to the lower blade dropping down when sailing, so the roots of the blades were linked with geared teeth, ensuring that they opened and closed together.

At the same time, an alternative approach was developed: the feathering propeller. Here, the blades are set at right-angles to the boss, as in a fixed prop,

PROP FACTS

The four main figures used to describe propellers are diameter, pitch, number of blades and rotation. **Diameter** is double the radius (distance from centre of the boss to tips of blades. As a rule of thumb, the more powerful your engine, the bigger the diameter you will need. **Pitch** is the measure of how far the propeller will advance in one revolution and thus how fast it will push your boat through the water for a given engine rpm (revolutions per minute). To understand pitch, imagine screwing a screw into a block of wood. The angle of the spiral thread governs how far it goes in for each turn. Similarly, the blades of a prop are set at an angle to the boss. The greater the angle, the greater the pitch. However, this is only the theoretical pitch. In practice, as water is not solid, the prop will slip to a degree and not advance so far. The amount of slip is around 30% for the props and speeds we are looking at.

Diameter and pitch are still measured in inches throughout the world – a quirk of history that would delight Henry VIII, and have Napoleon turning in his grave. But pitch can also be measured in degrees, especially relevant with feathering props whose blade angle can be varied.



The number of blades will vary between two, three or four, or even five in some high-speed craft. In practice, more blades will take greater power for a given diameter. For many years sailing boats used two-bladed props as they gave least drag in a boat with a full-length keel and an aperture for the prop, provided it could be locked in the vertical position. Today, most fixed props have three blades. Folding or feathering props have either two for cheapness, or three for higher power.

The hand of the propeller is the direction of rotation in ahead, when you are looking from astern. A right-hand prop is one that turns clockwise in ahead.

Blade area ratio (BAR), sometimes called disc area ratio (DAR), is the area of the blades as a percentage of the area of a circle the same diameter as the prop. A prop with a greater BAR will take more power, but have more drag. Figures for sailing boat props are around 60%.

The notion that a prop advances just because its blades are angled forward is a convenient way to imagine what is happening, but not strictly correct. The blades of a standard prop are in fact aerofoil in section, and move the boat forwards because as they spin round they develop lift, caused by a reduction in pressure on the back of the blade ('back' being confusingly the blade's forward face). The faster they go, the greater the reduction in pressure. Once a certain point is reached, the reduction in pressure causes the water next to the blade to vapourise and form bubbles. This is called cavitation, and limits the amount of power that a given area of blade can cope with. As the bubbles collapse, they erode the metal of the prop, resulting in surface pitting on the back of the blade.

but on swivelling hubs. When motoring, the blades swing to the ahead or astern angled position, but under sail they 'feather', turning parallel to the boss. One great advantage of feathering props is that they're suitable for the many fin-and-skeg and long-keel yachts that have a small prop aperture in the rudder, where a folding prop won't fit. In the earliest feathering props, the blades remain in the same orientation to the boss in ahead or astern, as with a fixed-blade prop. In astern the aerofoil is working backwards, giving less thrust than in ahead. Some new feathering props have blades that swing right round, so the same leading edge is presented to the water in ahead or astern. Under sail, the drag of folding and feathering props is tiny compared to a standard fixed-blade unit. Feathering props create about 5-10% of a fixed prop's drag, sometimes less, while folding props have almost zero drag. This gives a significant gain in sailing speed, between half a knot and one knot, with the greatest percentage saving at low speeds.

Inevitably, there are drawbacks. The first is expense: a folding or feathering prop costs between two and six times more than a fixed equivalent. The second issue is complication – the gearing and folding mechanisms are prone to wear and corrosion in the salty and sandy environment, leading to reduced performance, and even loss of blades in extreme circumstances.

The third problem is performance under power. The early folding and feathering props produced less thrust than an equivalent fixed prop, particularly in astern, with dire consequences if the blades fail to deploy when you need to make an emergency stop.

Now, the manufacturers claim to have addressed all the issues except cost. They claim the latest generation of their products give as good a performance or better under power, and major gains in speed under sail.

We put their claims to the test on two chilly days in February. To our folding and feathering props we added a fixed three-blade prop as a benchmark, and the Axiom prop, a radical new development in fixed propellers, just to see how it compared.

'Drag from a fixed-blade prop will add about four hours to an 80-mile passage'