Which Winch?

http://www.boatus.com/boattech/winches.htm

Choosing a winch may appear to be a trial and error process. Unfortunately, winches tend to be rather expensive, meaning that this is probably not the best way to go about it. What you need to do is to decide what you want from a winch. This is based on a number of factors, including the type of boat that you have and the kind of sailing that you intend to do. The one basic rule is that the larger a winch, the better it will function.

Initially, it seems that cruising boats require smaller winches than their racing counterparts. This is only partly true. While racers normally have more power to control, they also tend to have larger crews, both physically and numerically. If you don't have a gorilla-sized grinder to call upon, you'll need all the mechanical muscle you can get.

Comparison shopping for a winch (and we recommend that you do) can be a little confusing. This is largely because winch manufacturers love complicated mathematical formulas. The favorite is to use the "power ratio" of the winch as the basis of choice. Simply put, this is how many pounds of pulling power you will get from a winch for every pound of pressure that you put in. The formula is actually very simple-

2 x handle length x gear ratio ÷ drum diameter = power ratio

Technically, this means that a winch with a 10:1 power ratio will produce 100 lbs. of pulling power for every 10 lbs. that you put in. In reality, this is only a rough guide. There are other things that need to be factored in, such as the number of turns in the sheet, the friction produced by the lead blocks, and the operation of the winch itself. However, as a basis of comparison, the ratio is useful.

Winch Size

Most manufacturers make size recommendations based on boat length. While this is useful, a better option is to use the sail area of a boat, since this is a better guide for determining a craft's power. There are also other factors to be considered. How many crew do you have? How big and experienced are they? Where do you intend to place your winch? What are you planning to use your winch for? What type of sailing are you going to be doing? How much are you willing to spend?

When you're deciding on the correct size winch for controlling your headsails, use the sail area of the working jib or the 100% genoa. The smaller sail may seem like an odd choice, but bear in mind that it's used in heavier winds, so the sheets are subjected to higher loads. You can clearly see this by taking a look at the formula for load-

Load (lbs.) = SA x V2 x 0.00431

SA is the sail area, and V represents the apparent wind in knots. Therefore, a 300 sq. ft. sail set in 20 knots of wind will produce a load of 517 lbs. Using a 5:1 gear ratio winch with a 10" handle and a 4" diameter drum, you'd need to apply 21 lbs. of pressure to the winch to sheet in the sail. You may find that your boat's requirements fall between two sizes of winch. In this case, it is always better to step up to the bigger of the two, rather than making do with the smaller model.

Winch Placement

Remember, every change of direction that a rope makes en route to the winch causes friction and reduces the effectiveness of the equipment. When placing winches, avoid twists and turns, while also making sure that the rope comes into the winch at the proper angle. This means that blocks

and fairleads will be necessary. For genoas and heavier load lines, a turning block is needed to ensure the correct angle of entry to the winch. This should be between 3¡ and 8¡ below the winch's perpendicular axis. Ideally, the winch's output gear should be in line with the angle of entry. You will have to disassemble the winch to see this, but you can usually sight the entry angle fairly easily, without having to tear the equipment apart.

Winch Materials

Undoubtedly the best material for winches is stainless steel. It's strong and durable, but also expensive. The cheaper alternatives are anodized aluminum and chrome-plated bronze. Wire can damage both of these materials by rubbing the coating off. In addition, aluminum requires more upkeep. Straight bronze is very good, weathering to a classic greenish color that appeals to traditionalists.

Single-Speed Winches

Normally direct drive with a gear ratio of 1:1, these winches are perfect for halyards, cunninghams, or main and mizzen sheets on small and mid-size boats. We recommend that you buy one that ratchets, allowing you to crank the winch from both sides of the drum. This means that you can "push and pull" on the winch handle, rather than having to crank it through 360¡ in one direction. This is particularly helpful if you are unable to brace yourself against something to get your whole body into the cranking process. It's less tiring too!

Two-Speed Winches

These are normally used as the primary sheeting winches and halyard winches on larger boats. With both a high and low gear, these winches allow you to crank in ropes quickly to start with, then more slowly in a lower gear as the grinding becomes difficult. Gear selection is made by reversing the cranking direction.

If you get the placement right, it is possible to use one winch for multiple purposes. This allows you to buy one winch rather than several. However, we recommend that you carefully consider the different demands on the winch to avoid the difficult situation of trying to use one winch for several lines at the same time!

Self-Tailing Winches

These winches are generally more expensive, but they're worth it. They allow small frequent adjustments to sail trim and halyard tension without bothering the crew, as well as changing settings quickly. A favorite with racers and cruisers, we recommend them to anyone wanting to sail a boat to its maximum potential with minimal effort. To add to their convenience, a lot of these winches are offered with spring-loaded, self-adjusting jaws that accept lines of different diameters. Harken has a range of easy-to-use adjusting mechanisms for different ranges of line sizes. Just be sure that you check your range of line diameters before buying!

Electric Winches

Larger boats may need a winch with a 40:1 power ratio or higher. In this scenario, you may be tempted to go for an electric model. Provided your craft is equipped to handle the 50-140 amp power drain, there shouldn't be a problem. 24v winches are available to reduce the power draw. If you do decide on an electric winch, it's important that it has a manual backup in case of failure. Both Harken and Lewmar winches provide this option. They are also available in horizontal and vertical motor configurations to suit your requirements.

Winch Handles

Despite 10" handles being the industry norm, primarily because of their comfort, you should consider an 8" handle for lighter conditions. Here, speed is more important than ultimate power,

and an 8" handle allows for faster cranking. As you can see from the formula for power ratio, the length of your winch handle is important. If you find that you are getting insufficient power from a winch, try a longer handle before replacing the winch itself. Needless to say, this is a far cheaper option! A winch's power can also be increased if you use double-grip handles, allowing both arms to more easily grind the winch at the same time. We recommend that you use locking handles whenever possible to avoid losing them overboard. After all, a winch is a very expensive deck ornament without anything to grind them with. If you don't have locking handles, make sure that they are stored in a holder when not in use.

Winch Maintenance

As with your rigging, winches need some looking after if they're going to remain at their best. Be sure to rinse them in freshwater and cover them after every use. In saltwater, even more care is needed. They should be disassembled, inspected, cleaned and lubricated at least once a season. For aluminum models, this should take place three or four times a season to prevent oxidation. Both Harken and Lewmar offer service sheets for all of their models, and we have parts kits for both makes

Winches Magnify People Power (Harken website)

Because sailboats depend on human power to perform such tasks as sail trimming, rig adjustment, steering and sail changing, a wide variety of mechanical devices have evolved to allow relatively weak people to control highly-loaded systems. Block and tackles, hydraulics, and winches are the most common devices to magnify "people power."

Winches use two basic principles of physics to increase force: those of the lever and those of reduction gears. The handle is the lever as well as the input device used to drive the winch. the internal gears magnify power by reducing the speed of rotation.

Power
Power ratio is the term we use to describe the ability of winches to pull a load. Most manufacturers use power ratio as the name of the winch. For example, a 48 is a winch with a theoretical power ratio of 48:1 in the final gear. This means that for every kilo of handle input, theoretically 48 kilos of power is generated. Since a normal adult is capable of handling loads of 25 kilos, hypothetically, the winch can pull 1,200 kilos of sheet or halyards.

Power ratio is calculated as follows:
(handle Length/Drum Radius) x Gear Ratio.

Power ratio is traditionally calculated using a 10" (254 mm) handle length. Shorter handles decrease power. Drum radius can either be measured or found in the manufacturer's specifications. Gear ratio can be determined from the manufacturer's specifications.

In winches, as in any simple machine, speed and power are inversely related. If you want fast trimming, you will have lower power. If you want high power, you will have slow trimming. This is the reason that all moderate and large winches are offered with two or three speeds. For light loads, you can use a fast speed that doesn't offer much power, and as the load increases, shift to a higher power and trim the last few feet at lower speed.

Speed
When we talk about speed in a winch, we mean the amount of line that is pulled for each revolution of the handle. The primary considerations in determing winch speed are the gear ratio and the drum circumference. since the line is wrapped on the drum, each revolution of the winch will pull in an amount of

POWER
Handle Length/Drum Radius x Gear Ratio

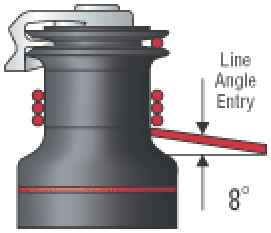
Low Power = Fast Trim (Light Loads)
High Power = Slow Trim (High Loads)

SPEED
Drum Circumference (2Pi x Radius) x Gear Ratio

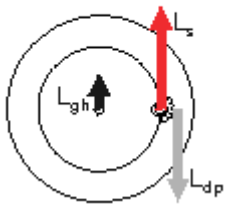
Wide Drum Diameter = High Line Speed = Low Power

Short Winch Handle = High Line Speed = Low Power

ALIGNMENT
Line Entry at Final Drive Gear Location = Decrease Load on Gear Housing and Drum Bearings

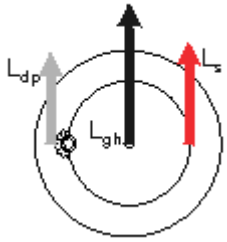


Case A



Ls = Sheet Load
Lgh = Gearing Housing Load

Case B



Ldp = Drive Pinion Load

line equal to the circumference of the drum (Circumference=2 pi radius).

When you are looking for a "fast" winch, you will use a wide body winch with a large diameter drum. Unfortunately, since the drum diameter is also a function of the power ratio, the wide body winch will offer less power for the same gear ratio. The average racing boat that uses wide body winches compensates for this loss of power by simply cranking harder, though a crew of musclemen is a luxury most club racers can't afford!

Faster winch speeds can also be achieved with three-and four-speed winches. A typical smaller three-speed winch, like the 48.3 offers direct drive in first speed. The drum turns one revolution for each revolution of the handle, so under low loads, sheets can be trimmed very fast. While this speed is not geared, there is a slight mechanical advantage obtained from the relationship between the lever (handle) and the drum diameter. Larger three-speed winches, from the 56.3 up, typically have a geared first speed because even under low loads, some additional mechanical advantage is required.

Four-speed winches are typically three-speed winches which offer a choice of a direct drive first speed or a geared first speed. The crew selects the appropriate first gear and then uses the three speeds available. For example, in light air upwind, or for most spinnaker trimming, they might well choose a direct drive speed for very fast trimming, while for tacking in a breeze they would use the geared first speed.

Another way to increase the speed of a winch is to use a shorter handle, typically an 8" (203 mm) handle. The 8" handle is faster because it swings in a smaller arc and a crew can rotate the handle faster. The same power problem is experienced, though, as handle length is a part of the power ratio calculation and decreasing the handle length 20% reduces power by 20%. Still, the 8" handle is a very effective and inexpensive means of increasing winch speed in light and moderate conditions.

Alignment

Other factors that influence the final power of a winch include whether two people can grind the last few feet of sheet using a doublegrip handle and even the placement of the winch on the deck. Many winches are positioned on coaming, which forces the crew to lean across seats or otherwise assume uncomfortable and inefficient postures. Runner winches are often difficult to grind because they are to windward where the crew is reaching up, rather than leaning over the winch.

Winches are further affected by how they are mounted on the boat. The most important factor is to ensure a proper line entry angle. Lines must lead up to a winch at about a 5-to 8-degree angle to prevent overrides of the sheet on the drum. If lead blocks are too high to allow this angle up to the drum, the winch must be raised slightly, or you will have serious problems preventing overrides. Using a knife to release a fouled sheet is dangerous, expensive, slow, and unnecessary.

It is also important to mount the winch so the line is properly aligned to the final drive gear pinion. Improper alignment dramatically increases the load on the gear housing resulting in inefficient operations, and in severe cases, in winch failure. Let's look at two examples: one with the load aligned properly and one with the opposite situation. In case A, with the proper alignment, the load on the gear housing is minimized since Ls and Ldp are in opposite directions. In case B, where the load is improperly aligned, the load on the drive gear is maximized - Lgh+L1+Ldp - but this time the loads are in the same direction and adding up