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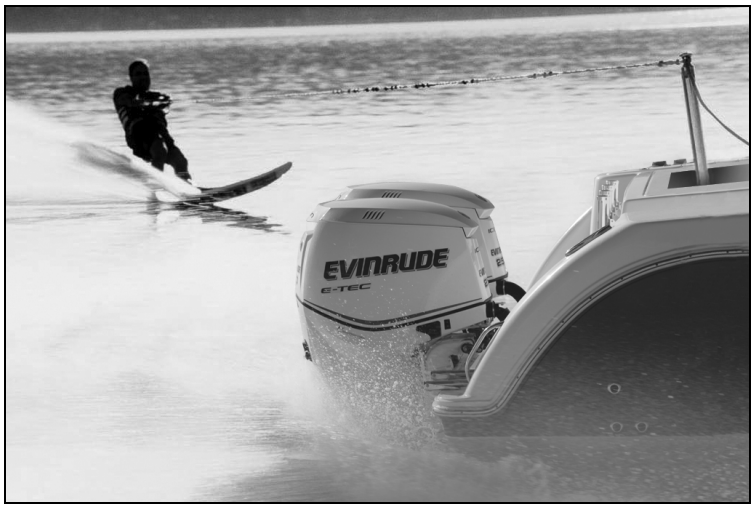
PROPELLERS

Where the Power Meets the Water!

Choosing the right propeller is the single most important decision you can make to get the best performance from your boat and outboard!

Propeller choice can affect boat top speed by as much as 5 to 10 MPH. It also has a direct effect on acceleration, cornering, pulling power, and fuel economy.

With some boats, you may need to change propellers for different activities, such as high speed cruising, water skiing, or carrying heavy loads. Using the wrong propeller in any of these applications will not only hurt performance, but could also cause engine damage.



Basic Propeller Terms

- **Leading Edge:** The edge of the blade closest to the boat.
- **Trailing Edge:** The edge of the blade farthest from the boat.
- **Blade Tip:** The point on the blade farthest from the hub. It separates the leading edge from the trailing edge.
- **Blade Root:** The area where the blade attaches to the hub.
- **Blade Back:** The side of the blade closest to the boat (low pressure side).
- **Blade Face:** The side of the blade opposite to the boat (high pressure side).

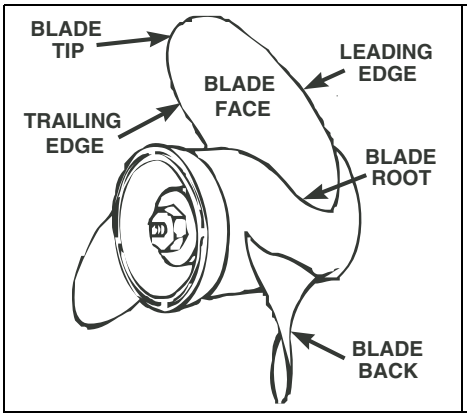
How Does a Propeller Work?

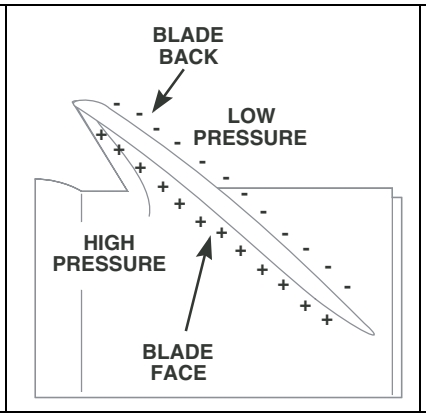
A propeller is a set of identical twisted blades, spaced evenly around a hub. Most propellers have a splined bushing in the hub that mounts on the outboard. The bushing attaches to the propeller with flexible rubber that acts like a shock absorber. If the propeller strikes something hard, the rubber helps protect against damage.

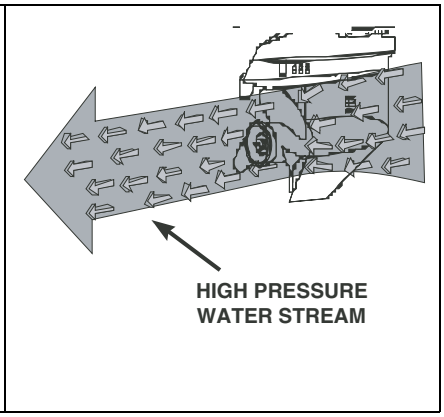
Newer propellers may use a multi-piece interchangeable hub system. Refer to Propeller Hub systems on Page 10.

Each propeller blade has two surfaces that displace water to move the boat. As the propeller rotates, the blade back creates a low pressure that helps pull the boat forward.

The blade face creates high pressure as it rotates. This pressure forces a stream of water away from the propeller. As the water is pushed to the rear, an equal force pushes the boat forward.





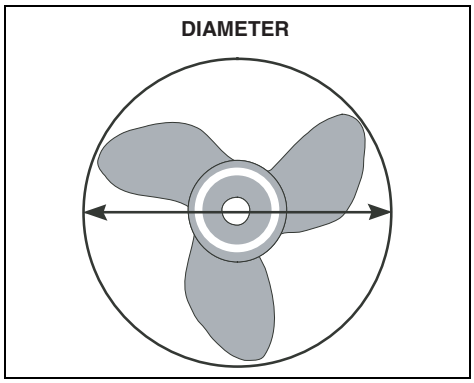


What to Consider When Shopping for a Propeller

Several characteristics affect how a propeller will perform. Especially important are propeller diameter, pitch, rake, and cup. Most propellers are identified by their diameter and pitch. Look for a number like 14¾ X 21. The first number is the diameter, the second is the pitch.

In addition, it is important to understand the effects of ventilation, cavitation, materials, and other application variables on propeller performance.

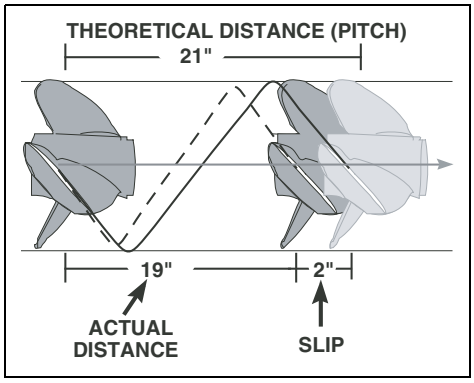
Diameter is the width of the circle described by the tips of the rotating blades.



Propeller diameter determines the amount of power a propeller can apply to the water—how much load the propeller can push. Generally, heavy loads require larger diameter propellers while small, fast boats are more efficient with a smaller diameter.

However, diameter is not usually a critical option when choosing a propeller. Focus instead on propeller style and pitch.

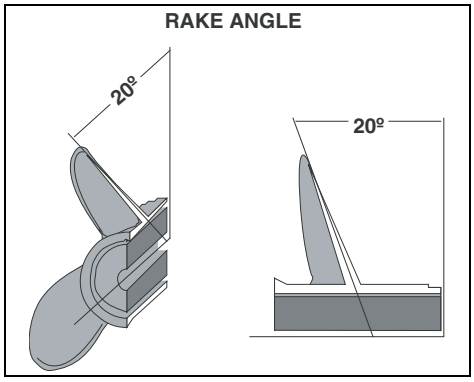
Pitch is the theoretical distance a propeller will travel in one complete revolution. For example, a 14¾ X 21 propeller would ideally move 21 inches forward with each revolution. In practice, the actual distance travelled is less than the pitch because of "slip" which is necessary to produce thrust.



Lower pitched propellers are like the lower gears on a car or bicycle. They create less forward travel with each revolution. A low pitch allows engine RPM to build up quickly, which gives faster acceleration and more pulling power. This works well for heavy loads, but results in slower top speeds.

Higher pitched propellers are similar to high gears. They create more forward travel with each revolution. A high pitch puts more load on the engine, which reduces low speed pulling power and acceleration, but usually provides more top speed.

Rake is the angle the blade tip tilts away from the gearcase. The angle is measured on a line extending from the center of the hub through the center of the blade. Rake can be either flat or progressive. Progressive rake means that the rake angle increases with distance from the hub.



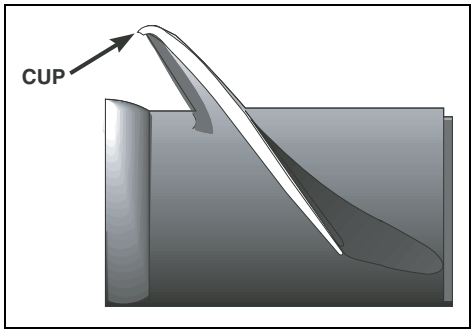
Most propellers have between 0º and 20º rake.

High rake propellers tend to lift the bow of the boat. On fast, lightweight, V-bottom boats, a high rake propeller should increase speed by reducing the amount of wetted hull surface.

When operated partially surfacing, high rake propellers reduce the amount of water being thrown off the blade by centrifugal force as the blade leaves the water. This allows high rake propellers to work more effectively in these applications.

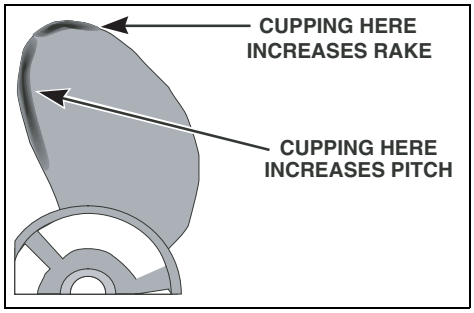
Tunnel boats and other air entrapment type hulls may become unstable when using a high rake propeller. In these applications, a propeller with less bow lift would be a more appropriate selection.

Cup is the small curved lip added to the edges of some propellers. Cupping acts like a seal on the edge of the blade. It keeps water on the high pressure blade face from flowing around the trailing edge to the low pressure area on the blade back. This reduces ventilation and slipping, especially when operating in disturbed or aerated water.

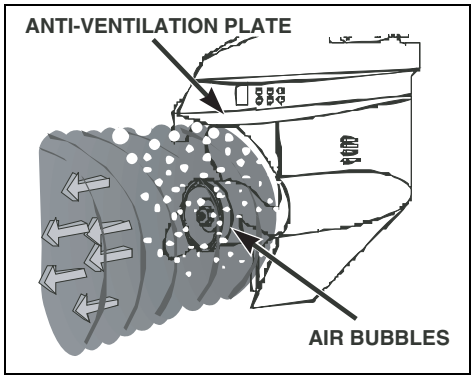


Propellers with cup excel in sharp turns and applications where the engine is mounted higher than normal. Cupping also allows the outboard to be trimmed higher for more bow lift.

Cupping the tips of the blades increases the effective rake, adding to the bow lift capabilities of the propeller. Adding cup to the trailing edge of the blades has the effect of increasing pitch. As a result, you can expect a slight loss of engine speed (150-300 RPM) when cup is added. However, the additional cup may allow the propeller to work at a higher transom height. Raising the motor will reduce drag on the gearcase and will often recover the engine speed.



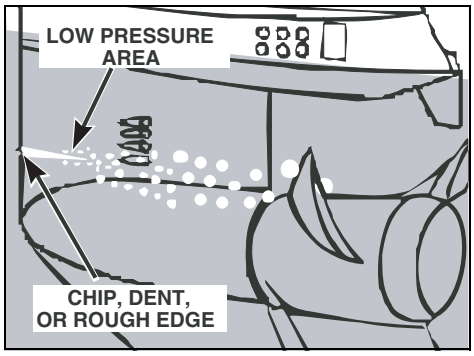
Ventilation is the result of air bubbles from surface air or exhaust gases being drawn into the blades. These pockets of air make a propeller lose its bite or thrust. Your RPM may climb wildly, yet you may not gain or lose speed. This is most common with high transom mountings, extreme trim settings, or sharp turns.



To help prevent ventilation, the outboard has an anti-ventilation plate directly above the propeller. For most applications, this plate should be within an inch above or below the bottom of the boat. On a high-performance boat, this rule does not necessarily apply. The anti-ventilation plate may be several inches above the boat bottom.

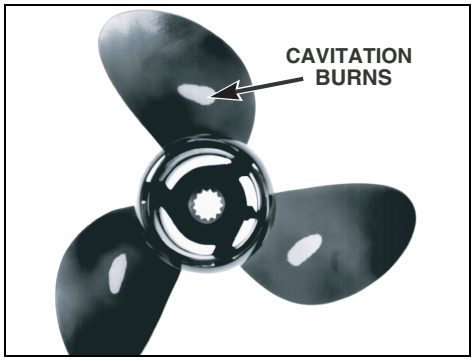
Water testing is the best way to determine the correct engine mounting height.

Cupped or high performance propellers help minimize ventilation.



Cavitation is caused by a disturbance of the water flow in front of the propeller. An irregularity in the boat bottom or gearcase, a misplaced transducer or speedometer pickup, or even a loose rivet can cause this problem.

Cavitation begins when a disturbance creates a low-pressure area in the water flow. As speed increases, the low pressure intensifies enough to vaporize (boil) some of the surrounding water. When the vapor bubbles approach a high pressure area, they collapse, releasing energy and causing damage.



The results of cavitation usually appear as burned areas on the gearcase or propeller blades. If the damage is substantial, performance is lost and the propeller should be replaced. In addition, the cause of the disturbance should be repaired to prevent further problems.

Material—Aluminum propellers provide a good balance of cost, performance, and durability for most applications.

Stainless steel propellers offer improved performance, fuel economy, and durability. Because stainless steel is five times stronger than aluminum, it is much less susceptible to damage from striking underwater objects.

However, the main advantage of stainless steel is in performance. Because of its strength, stainless propeller blades can be cast much thinner, which reduces drag. Stainless steel blades are also stiffer, which increases efficiency.

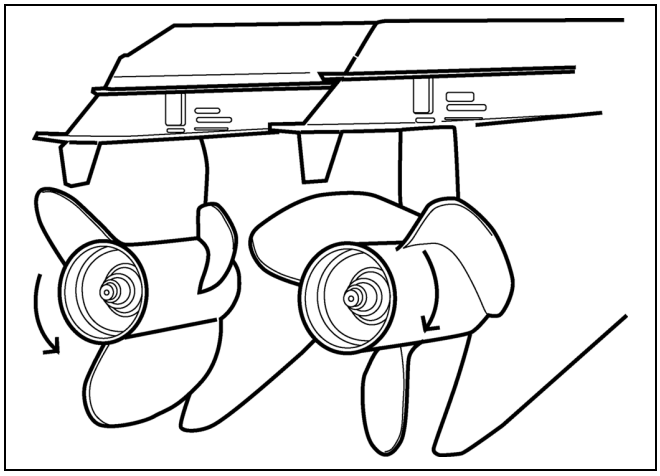
Composite and plastic propellers are generally used for emergency situations.

Blade Count—Theoretically, the fewer number of blades a propeller has, the more efficient it will be. But as the number of blades is increased, vibration is decreased. For most applications, three blade propellers provide the best balance between efficiency and smoothness.

However, *BRP/Evinrude* engineers have created a series of four blade propellers that provide increased efficiency and a superior grip on the water. The result is improved acceleration and better cornering in all water conditions.

In addition, when operated in a surfacing application, a four blade propeller keeps more blades in the water for maximum thrust and efficiency.

Rotation—Right-hand propellers are considered standard rotation propellers. To move the boat forward, the propeller rotates in a right-hand (clockwise) direction as viewed from the rear.



Left-hand propellers are considered counter-rotation propellers. To move the boat forward, the propeller rotates in a left-hand (counterclockwise) direction as viewed from the rear. Left-hand propellers must ONLY be used on an outboard equipped with a counter-rotation gearcase.

In a dual-outboard installation, the use of both right-hand and left-hand propellers balances the torque created by the rotation of the propellers. This helps to reduce the effort needed in steering and also helps to keep the boat level from side to side.

⚠ WARNING

For dual-outboard installations, always check to be sure propellers are installed on the correct engines before aggressively operating the boat.

Matching the Right Propeller to Your Boat and Outboard

Step One: Choose the propeller type designed for the way the boat will be used:

- Fishing, skiing, cruising, commercial, racing, etc?
- How many people will be on board?
- Is the water shallow, or are there rocks or other underwater objects?
- Will the boat be used for multiple purposes?

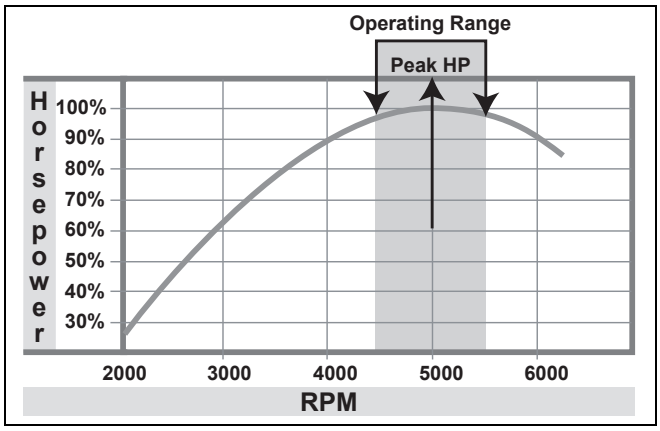
Use the propeller family descriptions in the following pages as a guide. For example, a Rebel™ propeller could be a good choice for a large, offshore boat. In contrast, a Raker® propeller provides bow lift, for increased top speed, on small, fast boats.

Step Two: Find the correct sized propeller for your specific outboard, boat, and load combination.

When selecting a propeller, start with the propeller charts in the following pages. These charts group all of the propellers designed for a particular outboard and provide detailed information such as pitch, diameter, style, and the number of blades.

To complete the selection process, you must perform a water test. During this running test, you will determine the best combination of engine mounting height, propeller style, and propeller pitch.

All *Evinrude* and *Johnson* outboards have a recommended full throttle operating range. This means that, at full throttle, engine RPM must never be below or above this range. These specifications can be found in the **Operator's Guide**.



The propeller provides the load that controls engine RPM. Reducing propeller pitch size will increase engine RPM at full throttle. Increasing propeller pitch size will decrease engine RPM at full throttle.

You have the correct propeller pitch when the engine runs at the midpoint of the full throttle operating RPM range with the normal, expected load in the boat. This is usually the point of peak horsepower. Choosing the correct propeller pitch for a given boat and application will ensure long engine life, along with best overall fuel economy and performance.

When you have a selection of propellers ready for testing:

1. Use an accurate tachometer to measure RPM and an accurate speedometer to measure boat speed.
2. Testing should be performed with the typical load—number of people, gear, water in live wells, etc.
3. Make sure that every test is with an identical setup.
4. Test each propeller at wide open throttle (WOT).
5. Engines should be tested at their optimum trim angle. This is the highest trim position the engine can be run without excessive ventilation, either in a straight line or in turns.
6. If the RPM is too low at WOT, try a reduced pitch and retest.
7. If the RPM is too high at WOT, test a propeller with more pitch. One pitch size usually results in a change of 200-300 RPM.
8. If the boat will be used for two applications, like water skiing and cruising, it may be necessary to test propellers for each type of use.

Step Three: Adjust the engine mounting height for peak performance.

The ideal engine mounting height provides the fastest boat speed without sacrificing acceleration, maneuverability, or engine water pressure. It is achieved by a trial and error method.

1. Start with the outboard's anti-ventilation plate even with the bottom of the boat.
2. Raise the outboard one mounting hole at a time until engine performance is no longer acceptable. Then, lower the outboard back down one hole.

Optimum engine height is affected by propeller style, diameter, and pitch. As you raise the engine, you may need to experiment with a variety of propellers to maximize performance.

Things to Remember

Check full throttle RPM often. It is possible that the propeller pitch size may have to change as the boating application or load changes.

- Adding or removing people can significantly change the power requirements placed on the engine.
- Changes in atmospheric pressure, temperature, and humidity all affect engine performance, which directly affects propeller performance.
- Salt water is more buoyant than fresh water; this may cause some hulls to run faster when moving from a fresh water to salt water location.
- The accumulation of marine growth or dirt—moss, barnacles, lime deposits, etc—is a major cause of poor boat performance.